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Ceramic Abstracts and the Bulletin

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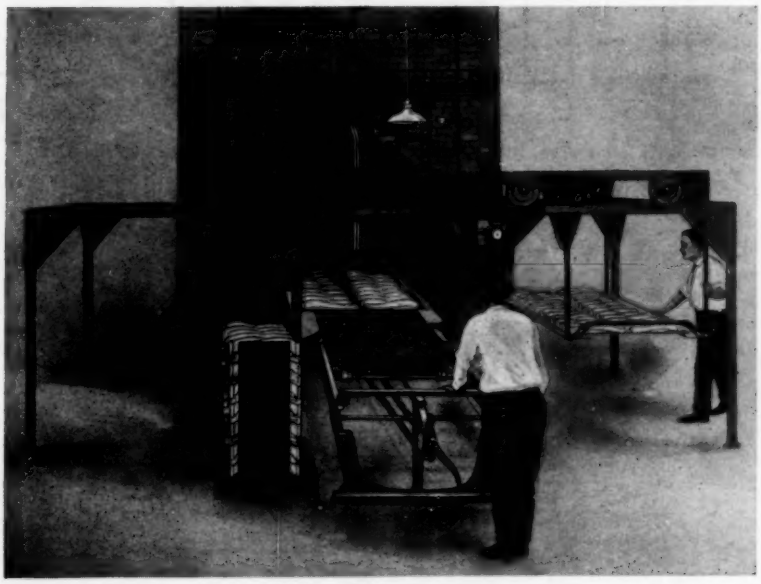

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Vol. 6 **December, 1923** **No. 12**

ORIGINAL PAPERS

AN ELECTRIC FURNACE TEMPERATURE REGULATOR[1]

By E. N. Bunting

ABSTRACT

The theory and operation of an electric furnace temperature regulator of the Wheatstone bridge type are discussed. The regulator is suitable for use with rectified alternative current as well as for direct current, and will maintain a close constant furnace temperature.

It is often desirable to control temperature as accurately as possible for laboratory measurements at elevated temperatures, and the Wheatstone bridge type of regulator described by White and Adams[2] and H. S. Roberts[3] has been successfully used. The regulator here described is also of this type, but differs from the others in the method of assuring constancy of temperature over long periods, and in that rectified alternating current, as well as direct current, can be used as the source of heat.

The main advantages of this type of regulator for small furnaces are the lack of an appreciable temperature lag between the heating element and the furnace chamber, the very close constant regulation obtainable, and the absence of any part of the regulator from the heating chamber.

Since the regulator holds the resistance of the heating element constant within narrow limits, the variations in temperature of this resistance de-

[1] Received Oct. 20, 1923.

[2] *Phys. Rev.*, **14**, 44–48 (1919).

[3] *Jour. Wash. Acad. Sci.*, **11**, 401–409 (1921); *Jour. Opt. Soc. Amer.*, **6** [9], 965–977 (1922).

pend upon the value of the temperature coefficient of resistance of the heating wire used, the larger the coefficient, the closer the temperature regulation.

Figure 1 is a diagram of the regulator. It operates on the usual 110 volts with furnaces having a resistance, when hot, of 3 to 15 ohms, using a current of not over 20 amperes.

As the resistance and temperature of the heating wire in the furnace vary, the arm of the galvanometer, G, oscillates between its two contact points, causing the polarized relay, PR, to operate the main relay, MR, which alternately introduces and removes the resistance, R_1, in the main supply line. With the correct setting of the rheostat the temperature within the furnace falls when R_1 is in the circuit, and rises when R_1 is short-circuited by the main relay. When operating, the fluctuations of temperature in the furnace occur from 20 to 80 times a minute, depending upon the setting of the rheostat and R_1 and upon the amount of separation of the contact points on the galvanometer.

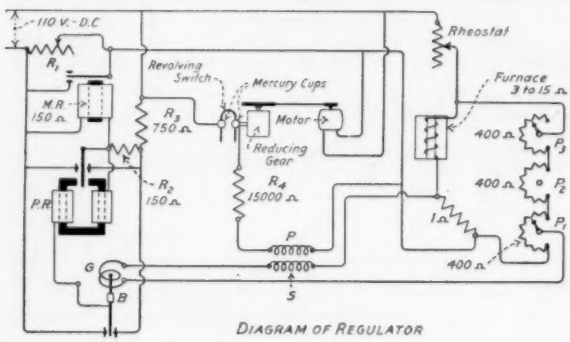

FIG. 1.

If the galvanometer arm sticks to one of its contact points very long, the cycle of operations is interrupted and a large change in the furnace temperature occurs. In order to prevent this sticking for more than a few seconds, the revolving switch as it passes through the mercury cups sends a small current through the primary winding, P, of a small bell transformer which induces a current through the secondary, S, and through the galvanometer coils. A momentary kick is thus given to the arm, causing it to break loose from the contact point, or to make contact should it have failed to do so as usual.

As a heating element any metal or alloy with not too small a temperature coefficient of resistance can be used, provided it does not oxidize or corrode very much at the temperature required. Iron wire can be used up to 300°C, nickel to 500°, and Monel metal to 750°. The alloy "alumel," can be used as high as 900°, but as its temperature coefficient at 800–900° is only .0007, the regulation may not be as close as desired. The wire or ribbon used should always be covered with a layer of alundum cement or other refractory material in order to reduce oxidation or vaporization. It is not advisable to use platinum much above 1500° for long periods of

time, as vaporization of the wire then becomes quite appreciable. For temperatures above 1600°, either iridium, molybdenum or tungsten can be used in specially designed furnaces.

The other quarter of the bridge in series with the furnace is a one ohm resistance made from a small temperature coefficient alloy, such as constantan, ideal, advance. Nichrome or chromel may also be used if very close regulation is not desired. The wire used for this resistance should also be large enough to carry the current used without becoming much hotter than 100°. All connections on this side of the bridge should be made either with heavy copper wire or with one of the alloys mentioned. The other half of the bridge consists of three 400-ohm variable resistances, P_1, P_2, and P_3, sometimes called potentiometers when used in radio receiving sets. These resistances need not be made from small temperature coefficient alloys, since the temperature is uniform throughout this side of the bridge. If the wire is scraped where the sliding contact is made, little difficulty should be experienced with changing resistance at the contact point.

The galvanometer is a modified portable Leeds and Northrup. The original pointer arm was removed and a piece of Pt-Rh thermocouple wire $^3/_4$-inch in length, flattened at one end, substituted. This wire was fastened to the stub of the original pointer by means of a small hollow cylinder of bakelite, B, into which the wires were sealed. Two contact points of the same wire were added and a loop of No. 40 copper wire six inches long run from the pointer arm to the fifth binding post, situated directly over the suspension wire. One millivolt applied to the coil terminals of the modified galvanometer produces a deflection of the pointer arm of about one millimeter. The contact points are six millimeters apart so that the arm makes contact at ± 3 millivolts. Any similar instrument, such as the Weston "Model 30, five binding post galvanometer" used by Roberts, will operate successfully.

The polarized relay, PR, is one of the usual telegraph type of 2000 ohms or more, resistance. With this resistance and those given for R_2, R_3 and MR, the current through the contact points of the galvanometer is reduced to approximately 8 milliamperes, at which value practically no corroding or pitting of the contacts occurs.

When not more than a 12-ampere current is used, an ordinary telegraph relay will serve as the main relay, MR, without undue sparking. After the alloy contacts of this relay wear out they should be replaced with molybdenum contacts, which will give much longer service. For currents of 12 to 20 amperes, the H_2 atmosphere mercury relay described by G. Barr[1] is recommended. This relay requires no attention and is also preferable for the lower amperage.

[1] *Proc. Phys. Soc.* (London), **33**, 53–56 (1920).

The value of the resistance, R_1, should be adjusted to give a variation of about 20% in the current through the furnace. The resistance, R_2, should equal that of the main relay, and R_3 should have a resistance such that sufficient current will flow to operate the main relay and the polarized relay without sending over 10 milliamperes through the galvanometer contacts.

The bell transformer is one of the ordinary type stepping down 110 volts to 12 volts.

When R_4 has approximately 15000 ohms resistance, the galvanometer arm receives a sufficiently violent deflection to prevent sticking. This resistance was obtained by soldering 3 *RCA* .05 megohm grid leaks in parallel.

The revolving switch consists of a U-shaped piece of nichrome wire sealed onto the slow motion shaft of the reducing gear. At each revolution of the reducing gear shaft, this wire passes through the surface of two mercury wells, thus completing a circuit through the primary of the bell transformer. The switch rotates about six times a minute. Since very little work is done by the gear, a $^1/_{20}$-h. p. motor, driving the gear by a small leather belt, is sufficient. The reducing gear runs in vaseline and is practically noiseless.

The following formula quite closely gives the variation in temperature, ΔT, of the heating element during each cycle of the regulator

$$\Delta T = \frac{2v}{\left[\frac{r_1 + \alpha r_0}{r_2 + r_1 + \alpha r_0} - \frac{r_1}{r_2 + r_1}\right] V}$$

where v = voltage required to close galvanometer contact (.003)
r_0 = resistance of heating element at 0°C (1Ω)
r_1 = resistance of hot heating element at temp. T(5Ω)
r_2 = resistance of bridge wire in series with furnace (1Ω)
α = temp. coeff. of resistance of heating element (.0039)
V = voltage drop across ends of bridge (60 at 1000°)

The values given in the parentheses apply to the furnace and regulator used in the laboratory here for which $\Delta T = .9°$ or $\pm .45°$ from the mean temperature. As the galvanometer arm occasionally sticks for a few seconds, the temperature of the heating element may occasionally vary a few times this amount. Since the heat capacity of the furnace walls and insulation is several times that of the heating element, the temperature variation at a definite spot within the furnace chamber is much less than the temperature variation in the heating wire, being at most only a few tenths of a degree.

As long as the physical properties and dimensions of the heating element do not change, the same setting on the bridge will always hold the furnace

to the same temperature, provided no large change in the room temperature occurs. As the heating wire oxidizes or vaporizes, the bridge setting, in order to maintain constancy of temperature, must be changed to compensate for the change in the wire. When a platinum heating wire is used, a constant temperature of 1100°C within the furnace can be held for days, without changing the bridge setting. Above 1200° the furnace will drop in temperature slowly and an occasional adjustment of the bridge setting is necessary to keep the temperature constant. At 1400° this drop in temperature amounts to 10° or more a day, due principally to the vaporization of the platinum decreasing the cross-section of the wire. Since the regulator maintains the resistance of the wire almost constant, it is evident that as the cross-section of the wire becomes smaller, the lower the temperature necessary to keep it at a definite resistance.

DEPARTMENT OF CERAMIC ENGINEERING
UNIVERSITY OF ILLINOIS
URBANA, ILLINOIS

A RECENT INSTALLATION OF A HARROP TUNNEL KILN[1]

By Gordon P. Gavin and Frank M. Hartford

ABSTRACT

The proper firing treatment for producing a large capacity of sanitary ware requires a car tunnel kiln of exceptional flexibility. A recent installation of a tunnel kiln, 360 feet $10^1/_4$ inches long, operating at cone 10 flat, is producing 540 pieces of bisque sanitary ware per day and has a firing cycle of $67^1/_2$ hours.

Oil is depended on entirely for fuel, there being no auxiliary gas or coal burning equipment.

Humidity driers are used in connection with this tunnel kiln and derive all their heat from the waste heat of the kiln.

Introduction

Slow Uniform Heating Necessary.—It has been demonstrated that in order to prevent heating-up cracks in sanitary ware, it is necessary to bring the piece up to red heat uniformly and comparatively slowly, and then raise the temperature quite rapidly to the maturing point. While it has been comparatively easy to secure and maintain a heating-up curve, or temperature gradient, having the same rate of temperature increase for every hour during the heating-up period, it has been a much more difficult matter to bring all the saggers on a car up to heat in the afore-mentioned desired manner, in which the temperature rise during the first part of the heating-up period is slow and then is sharply increased after the ware has come to a red heat; and to do this with a tunnel kiln firing a large tonnage of ware.

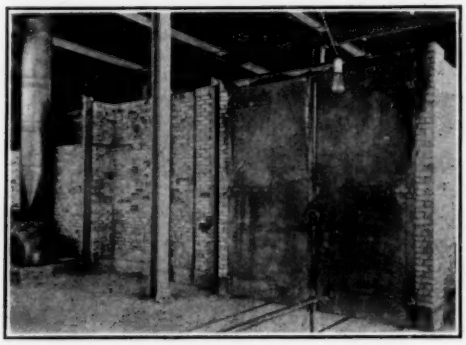

Fig. 1.—Charging end of kiln showing side entrance and draft fan.

Sanitary ware requires a kiln of great flexibility in order to secure and maintain the desired temperature gradient while producing a practical tonnage of number one ware. The kiln capacity—the amount of ware fired in twenty-four hours—must be sufficiently large to make the process worth while and to justify the cost of the installation. In order that a car tunnel kiln be practical, it must have a large capacity, require but little for maintenance, be simple yet efficient in design, and sturdily built. The mechanical members must be few and of excellent materials and design. Mechanical trouble should never be of such frequency as to be harassing to the operators.

[1] Presented before the Heavy Clay Products Division, Pittsburgh Meeting, Feb., 1923.

Description of Kiln

Size.—The car tunnel kiln recently built for the Kalamazoo Sanitary Manufacturing Company is 360 feet $10^1/_4$ inches long, is direct-fired, and is using 34–36° Baumé gas oil as fuel. The kiln has a placing width of 5 feet 4 inches and a placing height of 5 feet 6 inches.

Capacity.—This kiln contains forty-five cars under actual firing conditions. Although the kiln will operate at a capacity of 648 pieces of fired bisque sanitary ware per day, the plant production has not required that it operate at a greater capacity than 540 pieces per day. It has been operated at this latter schedule for approximately six months, and since the initial heating-up of the kiln until the time of writing this article, its performance has not been delayed for more than an hour.

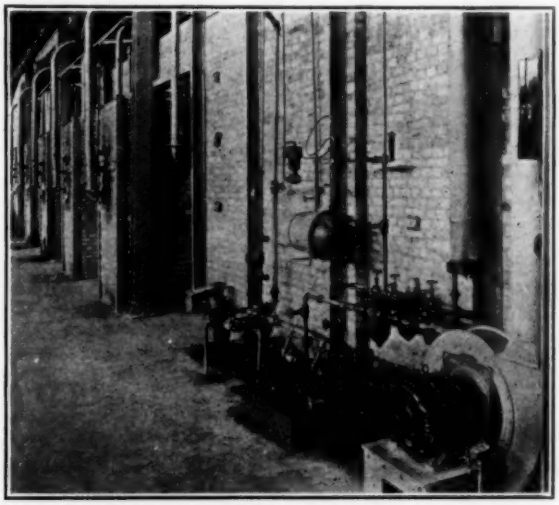

FIG. 2.—Furnace section showing fuel oil burning equipment.

Time Schedule.—It will be observed (Fig. 3), that almost one-half the time of the entire firing cycle is used in bringing the ware up to a good red heat, and approximately one-sixth of the firing cycle is devoted to raising the temperature of the ware from that point to the maturing heat of cone 10 flat. After the ware is matured the drop in temperature for a time is rapid, only one-seventh of the firing cycle being required to lower the temperature to about 1200°F. The remainder of the time in the kiln is used to bring the ware down to the discharging temperature indicated.

There are five furnaces on each side of the kiln or ten furnaces in all. However, only eight of these furnaces (four on each side) are under fire. A highly oxidizing atmosphere is maintained in the tunnel at all times. The furnaces are operated with a slightly increasing temperature in each pair of furnaces, the pair of furnaces farthest from the charging end of the kiln being the hottest and finishing off the ware at cone 10 flat.

Fuel Oil System.—The 34 to 36° Baumé gas oil is burned through low-pressure Sta-Kleen burners, the oil being supplied to the burners under sixty pounds pressure. The air used for primary air of combustion is

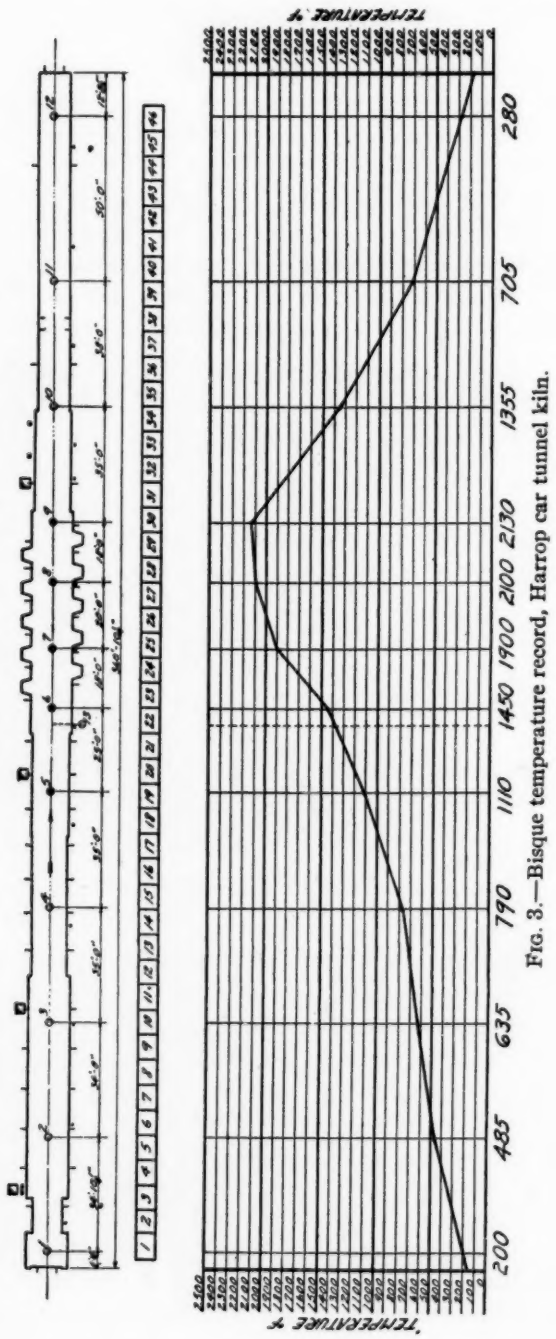

FIG. 3.—Bisque temperature record, Harrop car tunnel kiln.

fed through the burner around the oil at a pressure of 13 ounces. Approximately 1100 gallons of oil are consumed per 24 hours, oil costing about seven cents per gallon at the burner. Each unit is composed of a $^3/_8$-inch Viking oil pump, directly connected to a $^1/_4$-h. p. motor, with the necessary valves and strainers. Normally, only one unit is in operation and the other unit is reserved for emergency use. The pumps are so connected that either one or both may be used to maintain the oil at sixty-pound pressure.

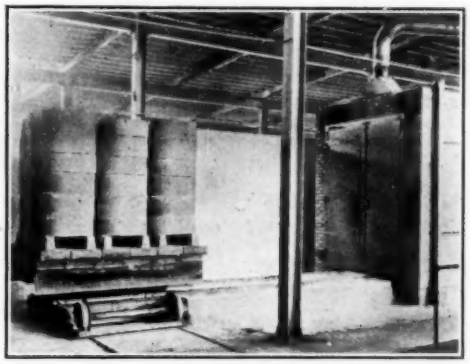

FIG. 4.—Discharging end of kiln showing car of fired ware.

Circulatory Fuel Oil System.—The fuel oil system is circulatory, with the return line emptying into the oil suction line through a pressure valve. This arrangement eliminates considerable load on the pumps, which would occur should the return line empty back into the oil reservoir and the excess oil again be lifted several feet. The piping system is also simplified by connecting the return line in this manner. The oil burning system also includes a 5-h. p. motor driving a pressure fan at 3400 r.p.m. and supplying air at the burner at upwards of 13 ounces static pressure.

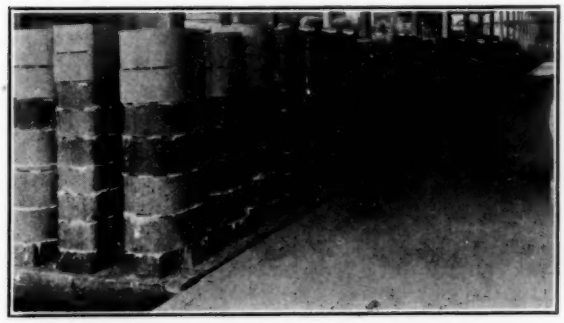

FIG. 5.—Return track, cars ready for charging into kiln.

Operation of Kiln.—The operation of the kiln is as follows: The loaded car is carried on the transfer car, at the charging end of the kiln, into the charging vestibule through doors on the side. A hydraulic pusher of 10-ton capacity (actual push being 8462 pounds) pushes the kiln car off the transfer car and in doing so gradually moves the whole train of cars in the kiln forward one car-length. At the time of charging the next car this same procedure takes place and the cars move slowly through the kiln, receiving as they advance the firing treatment previously described.

Method of Discharging Cars.—After a car is discharged from the kiln, it is pushed on to another transfer car at the discharging end of the kiln,

is carried over to an elevator and lowered to the return track level. The return track is at a lower elevation than the kiln track so that the bottom of the ware setting is level with the factory floor. This makes for ease in placing and drawing the ware. All the placing and drawing is done on this return track and when the trucks are again loaded ready for the kiln, they are raised to kiln track level by means of another elevator at the end of the return track opposite the first elevator mentioned and are charged into the kiln as described above.

The elevators, which are placed one at each end of the return track, are of the four-screw mechanical type much used in Michigan planing mills. There is a screw standard at each corner of the platform, the screws being arranged in pairs and each pair connected by means of a shaft with a pinion gear on each end. These pinion gears mesh with a lifting ring gear which runs on the screw standards. The two shafts are driven by one motor connected to same by silent chain drives. These elevators, carrying a load of about six tons, have proved very satisfactory.

Other Equipment.—In addition to the fuel oil burning system, the mechanical equipment on the kiln includes one 10-ton oil-gear hydraulic car pusher driven by a $^3/_4$-h. p. motor, one American Blower Company draft fan and one American Blower Company air supply fan, each of which is directly connected to a $7^1/_2$-h. p. motor.

Waste Heat Utilized

Another advanced application of time-saving equipment in connection with this kiln is the installation of humidity driers, the entire heat for same being supplied by the waste heat from the tunnel kiln. The kiln furnishes enough waste heat to the humidity drier to dry all the ware fired in the kiln. By means of this combination equipment, ware which formerly required twenty-one days to dry is now dried more thoroughly in eighteen hours.

Uniform Firing of Ware

This car tunnel kiln has proved very successful in firing the ware to a uniform cone 10 burn all over the car setting and with the losses in the kiln far below the normal kiln losses in a periodic kiln plant. This factory had two tunnel kilns each about three hundred and sixty feet long. Bisque ware was fired in the first tunnel and glost ware in the second. Glost ware is now fired in the two old tunnel kilns and all the bisque ware, necessary to keep the two glost kilns operating at full capacity, is fired in the new kiln.

66 S. Third Street
Columbus, Ohio

THE USE OF WOOD IN GAS PRODUCERS

By C. Saxton[1]

ABSTRACT

The possibility of using wood as source of gas supply for melting of glass and firing of clay products is suggested. Comparative results actually obtained with same plant using coal and wood are given.

Introduction

In determining the location of a new factory, one of the principal points usually considered is an adequate available supply of fuel at an economic price. For the manufacture of articles requiring high temperatures, this question becomes of particular importance because fuel usually is one of the largest items in production cost.

This very naturally is a great influence in limiting the areas in which ceramic factories can economically be operated, as otherwise the transport charges on the fuel may be prohibitive.

The fuels usually used for glass melting or clay firing are coal, oil or gas. From his own experience recently, however, the writer would like to suggest that it is possible to add another fuel, namely wood, to the three already mentioned, and thus in some instances enable factories to be operated successfully in areas which, while possessing many other desirable features, have so far been ruled out of consideration on account of fuel supply.

Wood in Gas Producers

The use of wood for the production of gas is by no means new, but the gas so produced has usually been used for operating gas engines. During the war many municipal gas works were compelled to use wood and sawdust.

It is essential, when using the gas from wood for either engine work or for illumination purposes, to extract the tar, whereas when it is to be employed in furnaces, extraction of tar is not only not essential, but in some cases it would really be a disadvantage.

Just after the Armistice the writer was operating a glass plant in France when it was impossible to obtain suitable French coal at any price. American and English gas coal were obtainable but at a cost so prohibitive it was a question of either finding an efficient substitute or shutting down the plant.

Oil was, of course, at first considered but its price was steadily rising, in fact did rise from 330 francs ($22) to 900 francs ($60) per ton.

It was desired that the one tank furnace be kept in operation, which fed two (old type) six arm Owens machines.

[1] A.M.I.E.E., M. Iron & Steel Inst. Received Oct. 8, 1923.

The gas plant consisted of two ten-foot gas producers of the hand-poked, water-jacketed type, provided with revolving grates. The blast was furnished by a motor driven fan, steam being admitted directly into the air pit under the dome of the grates.

These producers made the gas required for the main melting furnace, the two revolving pots and also two 7 by 75-foot leers. The melting furnace was only working at about one-half its capacity. It was big enough to melt 38–40 tons per day, whereas the machines were only pulling out about 20 tons (making small bottles). The labor available was anything but good, particularly the gas makers, who had a marked disinclination to use the poker, consequently there were times when the supply of gas was deficient even when using good coal.

Owing to the general shortage of coal, wood was being used quite generally in the surrounding districts for steam so there was not much difficulty in getting a stock of three or four hundred tons. Having heard that wood had been used with some success in an Italian glass works during the war, it was decided to give it a trial.

The first trials were half-hearted, as the wood was used on one producer only, in the proportion of about 20% wood and 80% coal. This percentage was gradually increased to 80% wood and 20% coal, with satisfactory results and finally all wood was used on one producer. The whole load on the producers was then transferred to the one using wood, by gradually shutting off the blast to the other one. At the end of 24 hours it was found that all the gas required was being supplied easily by the gasification of the wood; and the other producer was shut down. For a period of approximately nine months one producer gasifying wood was doing the same work and doing it better than the two had done on coal.

Kinds of Wood.—The wood used was principally white oak and evergreen or live oak, but at times a quantity of beech and elm were received, and in general it may be said that the best results were obtained with the hard woods.

State of Wood.—The wood was used in all stages of dryness, ranging from two days after cutting, with the leaves still green and fresh, to wood that had been cut for seven or eight months, which owing to the climatic conditions could be considered as being reasonably dry.

Sizes of Wood.—The sizes varied from small twigs of about $^3/_4$-inch diameter up to pieces 6 inches diameter, this being the maximum diameter accepted, the majority being in the neighborhood of three to four inches. Twelve inches in length was the maximum allowed to go on to the charging platform. These dimensions (6 inches x 12 inches) were decided in a purely arbitrary manner, as they happened to be the largest which it was considered would pass through the charging hopper without risk of jamming.

The cut pieces were taken up on to the charging platform in hoppers,

count being kept of the number going up and the weight per hopper was checked fairly frequently. All the sawdust, bits of twigs and bark and general waste was kept until the weekly "burning out" period. It was then fed into the producers during the time that the blast was off.

Operation of Producers.—No structural alterations were made to the producer but a thicker fuel bed was maintained. No steam was used at all in the air blast and the grate was kept rotating continuously at its slowest speed.

Owing to the impossibility of poking efficiently fears were entertained at first that there would be a tendency to develop blow holes in the fuel bed, but by keeping the grate continuously on the move, no trouble whatever was experienced.

The gas makers now had practically nothing to do but charge the hopper. They would persist in filling the producer almost up to the gas outlet and then having a long rest, a practice that was not tolerable. As a check on the frequency with which the producer was charged a sensitive recording pressure and draft gage with a center zero was connected to the gas outlet. Since each time the "bell" of the charging hopper was lowered there was a momentary recordable drop in pressure it was possible to obtain an exact control record of the number of charges made and the intervals between successive charges.

Ash.—As wood contains at the maximum approximately 1.5% ash, this question did not present any additional difficulties, but on the contrary, there was a good demand locally for the ash as an artificial manure. The ash was removed in the form of a greyish white sludge, absolutely free from any combustible material.

In order to ascertain when it was necessary to put in the plough to remove the ash, a U-tube was fixed with one leg connected to the air pit under the grate and the other in the gas outlet, so that the difference in the height of water in the two legs was a measure of the resistance of the fuel bed to the passage of the blast. When this rose above a predetermined figure the ash was removed.

It occasionally happened that too much ash was removed, but this was immediately evident by charcoal floating in the water in the ash pan. This charcoal was removed, dried and used in the batch.

Tar.—When using wood the question of tar trouble immediately presents itself but in the present installation no trouble at all was experienced owing to the flues being comparatively short and therefore hot, thus not giving the tar vapors an opportunity to condense.

By "burning out" thoroughly each week-end, even the two leers never caused any trouble in operation.

Economies of Wood in Gas Producers

FUEL CONSUMPTION

	Coal	Wood
Glass melted per day	20 tons	20 tons
Fuel used per day	26 tons	39 tons
Cost per ton delivered on to producer platform	360 francs	100 francs
Fuel cost per ton of glass	468 francs	195 francs

When considering the above figures it must be borne in mind that the fuel consumption includes that required for the two revolving pots and two leers as well as the actual melting tank, and also that the tank was only working at half its capacity which naturally increases the weight of fuel per ton of glass.

After the plant had been working some time on wood there was a steady reduction in the price of fuel and the comparative figures were then:—

	Coal	Wood
Glass melted per day	20 tons	20 tons
Fuel used	26 tons	39 tons
Cost per ton on charging platform	150 francs	60 francs
Fuel cost per ton of glass	195 francs	117 francs

Steam.—These results were naturally very gratifying but in addition there were several other economies and advantages. Taking first of all the steam item: very few of the smaller glass works appear to realize what it costs to generate the steam required for a modern producer using coal, but on this item alone there was a saving of 210 francs per day.

Labor.—By the replacement of gasmakers by laborers, and the shutting down of one producer an economy of 305 francs per day was made in labor costs.

Power.—The power required to rotate the grate was reduced from 6 h. p. to 2.7 h. p.

Taking into consideration fuel, steam and labor the relative costs per ton of glass were:—

Coal at 150 francs per ton	Wood at 60 francs per ton
226.3 francs	123.00 francs

Other Advantages

Several advantages to which it is extremely difficult to attach a definite financial value were obtained, among which may be mentioned having a standby producer in the event of anything unforeseen happening to the one in operation, and also the fact that everything worked without trouble or hitch usually associated with a small producer installation.

During the whole of the period that this plant was operating on wood gas, there was never a moment lost due to lack of gas or heat, or bad metal.

Conclusion

It will be easily seen that under certain circumstances the possibility of using wood as a source of gas for glass melting may become a proposition worthy of consideration, as there is not the slightest doubt that if a plant were to be designed and built with this object, it would easily be possible to improve upon the figures given. In the case just considered, all the arrangements were such that at the most they could only be termed makeshift in character, and in consequence not as efficient as could be desired.

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SOME VITAL FACTORS IN REDUCTION OF FUEL COSTS[1]

By W. C. Buell, Jr.

Introduction

It is a fallacy to suppose that any great fuel economy will come from the introduction of any particular fuel system. The first step in fuel saving lies in the detail design of the furnace and its fire box or burner setting, the design of the arch, flues, stack and the coördination of these with the fuel supplying mechanism of the equipment. A considerable economy can more probably be secured from well designed and properly built furnaces than from changes in fuel system. The second possible source of fuel conservation comes from the re-use of waste heat.

In heating operations at high temperatures, the gases of combustion become waste at temperatures greater than that of the substance being heated. In a glass tank furnace, and in the conventional down-draft kiln, the temperature of the products are in the neighborhood of 2500°F. In both of these, the gases of combustion leave the furnace at temperatures above this. Assuming that the gases leave at 2600°F under complete combustion the gases will contain about 65% of all the energy originally in the fuel or to put it in terms of dollars and cents, of $1.00 worth of fuel, 65 cents worth enters the flue. The 65%, of course, is only encountered at high temperature and if instead of 2500°F the gases leave the furnace at 1200°F, they will contain only about 27% of the total original fuel. The above range of waste gas temperature is roughly that encountered in the ceramic industry.

Salvaging of Waste Heat

Waste Heat Boiler.—There are three general methods of salvaging waste heat. Possibly the easiest method is using the waste heat to generate steam, and if large quantities of steam are used, very substantial economies may accrue from the use of waste heat boilers.

Drying.—A second method of salvaging this waste heat is to use it in drying processes. The brick industry has long made a practice of utilizing a small part of waste heat for the drying.

Recuperator.—The third method consists of returning a part of the sensible heat in the waste gases to the furnace proper by a regenerative or recuperative device, as in case of the glass tank and pot furnaces, and in the modern tunnel kiln.

Types of Recuperators

Recuperators are of two general types, those made with clay and those with metallic elements.

[1] Presented before the Glass Division, Pittsburgh Meeting, Feb., 1923.

Clay Brick or Tile.—The clay type is open to four rather severe criticisms: (1) the structure is fragile; (2) it is hard to maintain in a proper degree of tightness due to loosening of the cement; (3) the coefficient of heat transfer, as compared to metallic elements, is extremely low, necessitating a much larger structure to secure equivalent transfers; and (4) the initial cost is relatively great.

Metal.—Tile or other refractory material must be used in recuperators or regenerators, unless it is possible to maintain the temperature of the metallic elements at temperatures under 1800°F. This does not mean that clay devices must be used if the gas temperatures are above 1800°F. With the furnace gases entering the recuperator at 2500°F and the air from the recuperator heated to 1100°F, the temperature of the recuperator elements will approximate the mean of the gas and air temperatures; hence the metallic air containing elements would be approximately 1700°F.

Calorized Tubes.—Metal elements may be calorized to prevent burning out at high temperatures. In this process aluminum is driven into the metal so as to form aluminum alloy surfaces. These surfaces withstand the action of furnace gases at high temperatures and have a high rate of thermal conductivity at all times.

Economies of Metal Recuperators

Metallic recuperators can usually be applied to existing furnaces at quite a nominal cost and will bring about marked economies in operating cost and time, and an improved product.

It is often possible with metallic tubes to produce over-all savings in excess of 25%. It is possible to build a recuperator to return practically any percentage of the heat in the waste gases, although it has seldom been found profitable to carry recuperator design to a point of greater than 30 to 50% efficiency depending upon the temperature. The higher the operating temperatures, the more economical will the recuperation be.

Recuperation in Ceramic Plants

There are opportunities in the ceramic industry for fuel conserving equipment. Attention is particularly called to the "day tanks" and leers of the glass industry and the conventional down-draft kiln of the brick industry. There can, however, be no standard equipment designed for the purposes of recuperation, for each and every piece of fuel consuming apparatus is an individual problem and must be considered as such.

The pertinent question is what over-all fuel saving might be anticipated by the use of recuperators. No general rules will cover all cases, for a great number of factors, many of them individual to each shop, enter into the final result. It can safely be said that recuperation will not pay unless a direct fuel saving of 20% may be secured. The savings have been above

50%. It naturally follows that the better the shop practice the smaller will be the fuel saving and the poorer the present shop practice the greater will be the saving.

A large saving from the use of recuperators is in the quantity of fuel used. The lower amount of fuel per quantity of product will usually give an over-all saving much greater in proportion than the percentage of heat returned by recuperation. The flame temperature of the fuel is higher and a more rapid combustion reaction is secured and a higher temperature differential within the furnace is maintained. As heat transfer varies directly as the fourth power of the increase, even a slightly higher flame temperature will enormously speed the operation with the result that the time factor is materially reduced.

The time is now with us when fuel costs must be reduced both from the point of earnings and the conservation of the fuel resources of the country.

BUELL, SCHEIB, MUELLER, INC.
PITTSBURGH, PA.

Discussion

W. B. CHAPMAN:—Mr. Buell's statement that usually 27% of the fuel can be saved by preheating the air is conservative, provided the air is sufficiently heated.

Not long ago we went over the figures of eight typical furnaces we have built and the average saving of fuel due to high temperature recuperation, as compared with little or no recuperation, was slightly over 30%. Therefore, it is reasonable to accept the 27% mentioned by Mr. Buell as a fair estimate. It seems to be the custom in this country to rebuild old furnaces, rather than build new ones. The patent hollow tile method of recuperation which we employ does not lend itself very readily to the remodeling of old furnaces: therefore the use of calorized pipe which is well adapted to remodeling old furnaces will open a large field and supply a real need. For every new furnace built there probably are opportunities to rebuild or remodel ten old ones. I believe, however, that the higher temperature operations are not suitable for calorized metal recuperators—I think Mr. Buell mentioned 1800° as possible.

With plain cast iron recuperators of the old-fashioned kind the air was preheated usually to but 400°F, and even this small amount of preheat was found well worth while. Mr. Buell claims that calorized, mild steel pipes will stand a temperature of 1800° and he mentions having preheated the air to 1400°F in a recuperator made of calorized pipes. This is a big gain over old practice with cast iron pipes where 700°F is the highest limit and 400°F the usual working practice.

Furnaces often get out of control and the temperature of the spent gases often rises far beyond what it should be, therefore, even if calorized steel tubes can be heated twice as high as is safe with plain cast iron there

still is much more to be desired. For in all high temperature furnaces the temperature of the spent gases is well beyond the limit of calorized steel tubes. Therefore, although calorized steel tubes may be used to advantage in rebuilding an old furnace and are exceptionally well suited for low temperature furnaces such as heat treating operations, when it comes to the most efficient and safest recuperator for high temperature furnaces there is nothing better for a recuperator than special hollow tile made of high grade refractory material. With a properly designed recuperator made of good refractory clay we have found it possible to preheat the air to 1950°F and keep it up continuously without any risk to the life of the recuperator. The temperature of the spent gases on the other side of the tile in this recuperator is about 2350°F and the average temperature of the tile itself is therefore 2150°F.

The higher you heat the air the greater the theoretical saving and in practice the saving is found to be even greater than in theory, for the more you preheat the air the less excess air you need and the better it combines with the fuel. Therefore, if you are burning oil, the higher the air is preheated the less you need to be careful about atomizing, and if you are burning powdered coal the higher the air is preheated the less finely the coal has to be pulverized. This reduces the cost of pulverizing and also insures more complete combustion.

With oil fuel it has been thought necessary to use a certain amount of air or steam to spray it into the furnace. This is no longer necessary. There are a number of devices working successfully. I know of an extreme case in a Russian design of open hearth furnace where fuel oil is merely dripped into the draft of highly preheated air at several different points across the air port—no attempt being made at spraying. In France our associates installed an open hearth furnace of this type a few years ago and although everyone was rather skeptical at first the owners of the steel works after having one in operation for some time put in two more. In this country oil burning without steam or air under pressure was first developed by one of the glass manufacturers present. With this new and improved method all of the air can be preheated with its consequent advantages and economy.

I believe that there is a great improvement coming in this country in fuel saving and furnace operation generally, not only in the glass industry but in other lines as well, due to the general recognition of the need of doing much more preheating of the air to high temperatures than heretofore.

A MEMBER:—A saving of 30% is conservative. It runs higher than that in a great many instances. One point that impressed me strongly about high temperature recuperation was the increased furnace capacity and efficiency made possible by the increased differential between the flame temperature and the material heated.

A SKIAGRAPHIC STUDY OF FABRICATED GLASS ARTICLES[1]

By C. D. Spencer and A. E. Badger

ABSTRACT

A method is described whereby defective construction may be determined in fabricated glass articles. The principle is the same as that of the immersion method of grading optical glass. The glass object is immersed in a fluid whose refractive index for some monochromatic source of illumination is approximately equal to that of the article. Under these conditions it is possible to observe defects in the structure of complicated glass objects.

Introduction

The production of glass articles of any form entails various percentages of breakage, depending on the complexity of the resulting product. The cause of breakage in many instances is a defect of construction. The object of this paper is to describe a simple method for determining defective construction in fabricated glass articles.

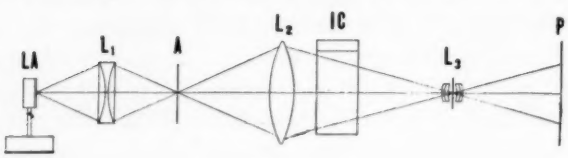

Fig. 1.

The Method Described.—The principle of the method is illustrated in Fig. 1. This is the usual set-up for observing and photographing striae in rough chunks of glass. It is a simplification of the immersion method used in grading optical glass. The source of monochromatic light, LA, is a mercury arc. L_1 is a condensing lens which forms an image of the source of light on the small circular aperture, A. By means of a lens, L_2, either parallel or slightly convergent light may be passed through the immersion cell, IC. If the object is to be photographed, a lens, L_3, is used to form an image in the plane, P. The lens, L_3, may be either the lens of the eye, for visual observation, or the objective of a camera. For visual examination mercury green light is used for illumination. If it is desired to record the image photographically, lantern slide plates may be used, but since they are relatively insensitive to green light mercury blue light should be substituted. The refractive index of

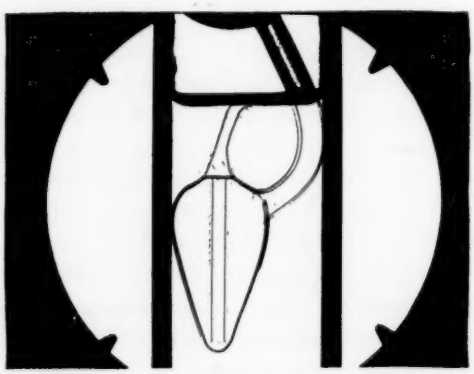

Fig. 2.

[1] Received Sept. 29, 1923.

the immersion fluid is then adjusted until a sharp image is obtained. For ordinary lead and lime glasses, monochlorobenzene may be the immersion fluid. The refractive index of this liquid may be adjusted by the addition of small quantities of carbon tetrachloride or monobromonaphthalene.

The Skiagraph.—The resulting image, visual or photographic, is termed a skiagraph because it appears as a cross-section of the object under examination. This is illustrated in Fig. 2. The object in this case is a bulb of a potash tube, and the skiagraph shows clearly the form of the seals between the bulb and the tubes. Fig. 3 shows the cross-section of a construction involving the sealing of a tube within and concentric with a larger tube. In the first case, "A," we have illustrated the acute angle seal. This form of seal between two surfaces is to be avoided because it invariably results in excessive breakage. Fig. 3, "B," shows the same construction, but with an arched seal. This type of seal can be made with practically no breakage.

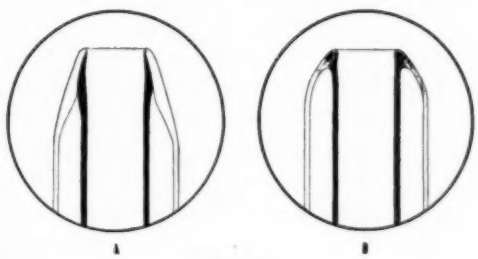

FIG. 3.

The reason for the excessive breakage in the acute angle seal construction, is the stress introduced during the cooling of the glass from the plastic condition. That portion of the glass in the neighborhood of the apex of the acute angle cannot cool as rapidly as other portions and this uneven cooling results in a stress in the glass at this point. The presence of this stress can be demonstrated by a modification of the set-up shown in Fig. 1. For this purpose it is necessary to convert the set-up into an immersion polariscope, by the use of two Nicol prisms and a sensitive tint plate.

Other modifications of this set-up have been used. For instance, a Balopticon forms a handy means for projecting a skiagraph at any desired magnification. In case only one print is to be made, photographic paper can be substituted for the film or plate. It is not necessary to use monochromatic light for illumination when the skiagraph is taken on a photographic paper. If the index of refraction of the immersion fluid for deep blue light is about the same as that of the article under examination, the resulting photographic image will be quite sharp.

GLASS TECHNOLOGY DEPARTMENT
NATIONAL LAMP WORKS
GENERAL ELECTRIC COMPANY

A BETTER DESIGN FOR A JUG MOLD CLINCH

By Paul E. Cox

ABSTRACT

A design of a clinch is shown that is suitable for all shouldered ware. This design will give longer life to the molds, yield a better looking product, and do away with cracking at the clinch, and the jiggerman can work more rapidly and easily.

Introduction

Jugs and other shoulder ware made in the usual type of molds have the clinch below the shoulder. Thus the contour of the ware is injured by a ridge which is always at the seam. Since the jiggerman cannot get his hand or a tool inside of the jug, it is apparent that the seam resulting from the usual type of jug mold clinch is a roll of clay a little distance from the shoulder. The cleaning of the jug is rendered difficult on account of this irregular roll of clay. The design described moves this seam to the edge of the shoulder where it is not objectionable in the finished product. Seams on such ware as pickle jars with their open tops can be smoothed with the jiggerman's tommy stick, a stick with a sponge fastened on the end, but with the seam right at the shoulder this work is not needed.

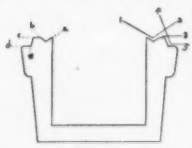

Fig. 1.

Figures 1 and 2 show the usual type of jug mold clinch. In use the edges marked *a* wear down rapidly due to (1) the grinding action of the clay, (2) the dissolving action of the moisture in the clay, (3) the abrasion of the scrapstick used by the jiggerman. The welding together of the two pieces that make up the jug will not be as effective because the jiggerman has the habit of scrapping the work in one direction only. A new mold will shear the surplus clay away and the remainder will be welded. An old one will not do this. A new mold will also cut the clay off entirely or leave but a very thin layer between the knife edges, while an old mold will leave a ridge of clay by which the jug is suspended in the mold during drying. More or less strain is thus set up in the clinch depending on how far drying has progressed, due to the weight of the suspended part of the jug.

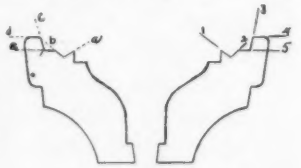

Fig. 2.

In Figs. 1 and 2 the lines marked with the numerals 1, 2, 3, 4 and 5 show the changes of position the right hand of the jiggerman must make in scrapping the clay from the two parts of the ordinary mold. The letters *a*, *b*, *c*, *d* and *e* show the surfaces that the jiggerman must clean from 800 to 1200 times a day or a total of from 8000 to 12,000 surfaces. It is not easy to clean the top part of this kind of jug mold and to do it rapidly.

The numerals 1, 2 and 3 in Fig. 3 show the positions the jiggerman's right hand would take in scrapping the bottom part of this mold, while

the letters *a*, *b* and *c* indicate the surface that must be made relatively clean 800 to 1200 times a day. Two movements per jug have been done away with in this bottom mold, saving a fast jiggerman 2400 movements of his wrist per day, and an ordinary one 1600 movements. In practice it was found that a good jiggerman seldom had to clean surfaces *b* and *c*, thus saving close to 4800 wrist movements per day for this lower part of the jug mold. Figure 4 shows that the jiggerman must move his wrist three times for scrapping the top part of this jug mold. The letters indicate the surfaces that must be made approximately clean. In practice it was not always necessary to clean surface *c*, but to gain time, it was found wise to scrap it. Instead of the jiggerman moving his wrist from 4000 to 6000 times per day he need make only 3600 movements per day.

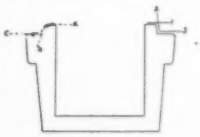

FIG. 3.

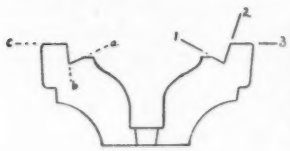

FIG. 4.

It will be seen that this type of mold eliminates a total of 7200 movements per day and while they are all slight movements considerable pressure is applied and energy is used in doing each of them.

Figure 5 shows how the scrapping of the clay is done to insure a good clinch. It is easy to scrap a jar mold and the machine will work the clay above the level of the mold, in spite of the jiggerman's efforts. The jiggerman can then use his scrapstick in the jug mold in such fashion that the clay is not entirely cleared from the mold top, leaving a little wedge around the mold. This is shown in the drawing (Fig. 5). The dotted lines show the shape into which the clay should be scrapped so that when the two parts of the mold are put together the outward pressure will effect a smooth clinch. This upper mold scrapping should be so done that a cone presses down into the neck of a hollow cylinder. The shape of the plaster work makes this work automatic for the jiggerman. It was found that a very slight distortion of the clay took place and that this was in the exact angle of the shoulder.

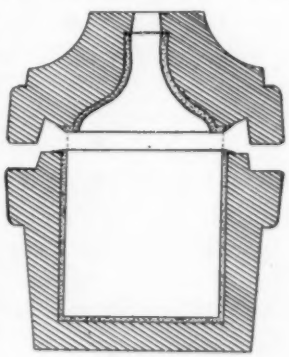

FIG. 5.

The block and case work is greatly simplified in this process. This experimental work was done with the assistance of a stoneware jiggerman who kept a record of jugs lost through the cracking of the clinch. In several months' time only five jugs were lost, a number of these resulting from carelessness.

IOWA STATE UNIVERSITY
AMES, IOWA

THE BEHAVIOR OF FIRE BRICK IN MALLEABLE-IRON FURNACE BUNGS[1]

By H. G. Schurecht and H. W. Douda

ABSTRACT

Purpose.—An investigation was conducted to study the requirements of fire clay and bodies used for fire brick in malleable-iron furnace bungs. Tests were made on complete bungs holding forty sample brick in malleable-iron furnace bungs with twenty different fire brick. Laboratory tests were also made in conjunction with them.

Results.—The spalling tests bear the closest relation to the service test; those brick losing less than 10% withstand more than fifteen heats.

There is also a relation between the porosities and densities of fire brick, which lie between 15 and 28% and 1.5 and 2.6%, respectively, for the best brick.

There is no close relation between the load test and softening-points of fire brick and their lifetime in malleable furnace bungs, so these tests are no criterions in judging the serviceability of brick, provided the brick are sufficiently refractory to support the arch at furnace temperatures.

Methods for Improving Fire Brick.—The resistance of a brick to spalling may be governed by: (1) the selection of the proper clays, (2) the size of grain and the proportioning of the non-plastic ingredients, (3) the fineness of grain of the bond clay, (4) the manner of molding, and (5) the temperature of firing.

Introduction

In the utilization of fire clays for malleable-iron furnace bung brick, manufacturers have experienced more or less trouble in producing brick of high service due to lack of knowledge of the constitution and properties such a brick should possess. Brick made of clays passing the customary load and softening-point tests often fail when used in malleable-iron furnace bungs. For example, in one case a brick standing a very high load test at furnace temperatures failed under three heats in practice, whereas another brick failing in the load test stood an average service test of 17.5 heats.

In the selection of clays for bung brick, actual service tests are too time-consuming, whereas laboratory tests can be made in much less time. A more thorough study of the relations existing between the laboratory tests of bung brick and their ability to stand up in practice was, therefore, undertaken by the Ceramic Station of the U. S. Bureau of Mines. Although the investigation was limited to brick used in malleable-iron furnaces, the results may be applied to refractories for other furnaces requiring similar service.

Description of Tests

Tests in Practice.—Complete seven-foot arches containing 40 brick were tested as shown in Fig. 1. The number of heats withstood by the

[1] By permission of the Director, U. S. Bureau of Mines. Presented before the Refractories Division, Pittsburgh Meeting, Feb., 1923.

different arches in practice was used as a method of comparing the serviceability of the different brands tested. All the bungs were placed in a definite position over the fire box where they received the same and the severest heat treatment of the furnace. After each heat they were removed from the furnace during re-charging. This chills the brick and tends to cause spalling. The tests were made in a forty-ton malleable-iron furnace operated by the Ohio Malleable Iron Company, Columbus, Ohio. Three or more bungs of each brand of brick were tested.

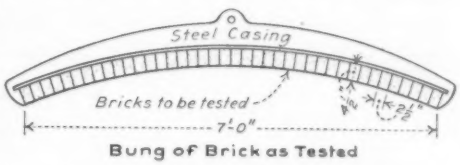

FIG. 1.—Bung of brick as tested.

Laboratory Tests.—The following laboratory tests were made on each brand of brick: (1) per cent spalling loss; (2) per cent deformation under load; (3) density; (4) per cent apparent porosity; (5) softening temperature; (6) chemical analyses; (7) permeability of gases.

For the spalling test four or more brick of each brand were selected, discarding those showing cracks and flaws. The brick were dried at 110°C for five hours or more, and weighed.

The test furnace was heated to 1350°C and held at this temperature for one hour. The brick were then placed in pairs in $5^1/_4$ inch x $4^4/_6$ inch openings left in the doorway of the furnace with the $2^1/_2$ inch x $4^1/_2$ inch ends exposed to the fire, and heated one hour before quenching.

Two brick at a time were removed and plunged into running water (about 20°C) to a depth of four inches and held there three minutes, after which they were removed and allowed to dry three minutes in air. As soon as two brick were removed from one of the openings they were replaced by two others, thus preventing cooling of the furnace.

Each brick was heated and quenched ten times. After the tenth quenching they were dried at 110°C for five hours and all particles easily removable by the fingers were broken off. The brick were then weighed and the percentage loss in weight calculated on the original weight as basis.

The resistance of fire brick under load[1] was conducted by applying a load of twenty-five pounds per square inch to the brick and heating them to 1350°C, and holding the furnace at this temperature for one and one-half hours. The per cent deformation was noted and used as a measure of the resistance to load at furnace temperatures.

The softening temperatures were determined by comparison with standard Orton cones.

The apparent densities and porosities were determined by the water and oil immersion methods and calculated as follows:

[1] H. G. Schurecht, "A Machine for Testing the Hot Crushing Strength of Fire Brick." *Jour. Amer. Ceram. Soc.*, **2** [8], 602–7 (1919).

$$D = \frac{W_d}{V_b} \qquad P_a = \frac{W_s - W_d}{V_b} \times 100$$

D = density
W_d = dry weight
V_b = bulk volume (true clay volume plus pores)
P_a = per cent apparent porosity
W_s = saturated weight (saturated in water)

The permeability of gases through the brick was measured by forcing air at a low pressure through the two and one-half inch thickness of the brick, and the permeability factor was calculated from the formula below:

$$V = \frac{c\,l}{t(P - Po)A}$$

V = permeability factor
c = cc. air passing through
l = length in cms.
t = time in seconds
P = average pressure
Po = initial pressure
A = area in cm. of cross-section

Results of Tests in Practice and in the Laboratory

Part of the results of this investigation are shown in Tables I and II and Figs. 2, 3, 4, 5, 6 and 7. The results indicate that the load test is no criterion of serviceability in malleable-iron furnace bungs. For example, bricks B and A behaved poorly in the load test, but stood up well under service, while bricks I and M stood up well in the load test, but behaved poorly in service. Obviously the brick should be strong enough to support the arch at high temperatures, but any extra strength above a safe limit is unnecessary. Brick deforming as much as 6.35% under the load test in some instances gave excellent service in the malleable-iron furnace bungs.

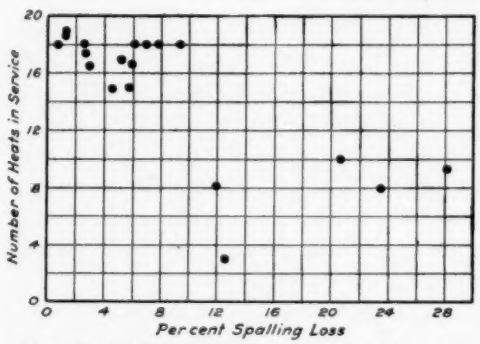

FIG. 2.—Relation between serviceability and spalling losses of fire brick.

The softening-point of malleable-furnace bung brick should be sufficiently high to prevent the brick from melting, but it is not necessary for them to stand a high softening-point test, *i. e.*, cone 31 or above. Brick having a softening-point of cone 30 often give as good service as those softening at cones 31–33.

The closest relation of the tests made appears to be between the per cent spalling loss and serviceability. Those brick showing the smallest spalling loss stand up best in practice (see Fig. 2). When the spalling loss was above 10% the number of heats which the corresponding brick withstood in practice were below 15 in each case.

Bricks A, B, to N, were tested when the malleable-iron furnace operated one heat per day. When O, P to S were tested these furnaces operated

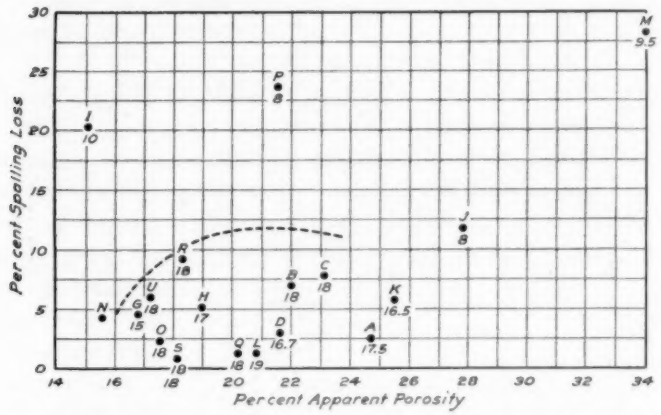

FIG. 3.—Relation between spalling losses and porosities of fire brick and their serviceability.

two heats per day, which treatment was less severe on the bricks than the former method, since the bricks were not as thoroughly cooled in the second

TABLE I

THE CHARACTERISTICS OF MALLEABLE-IRON FURNACE BUNG BRICK

No.	No. heats in malleable furnace bungs	Per cent spalling loss	Per cent deform under load	Softening point of brick cones	Softening point of bond clay cones	Density	Per cent apparent porosity	Permeability of gases
L	19	1.30	0.90	.....	.....	2.282	20.87	0.0197
O	18	2.21	....	.....	.....	1.919	17.46	.....
Q	18	1.16	....	.....	.....	1.935	20.19	0.7405
U	18	6.07	....	.....	.....	2.101	17.18	.....
R	18	9.23	....	.....	.....	1.927	18.29	0.1435
S	18	0.85	....	.....	.....	1.925	18.06	0.2105
B	18	6.94	4.85	30–32	30–31	2.044	22.04	1.3657
C	18	7.92	1.95	32	32	2.025	23.15	.....
A	17.5	2.56	6.35	.....	.....	1.985	24.78	.....
H	17	5.18	0.40	32	30	2.043	19.03	0.3023
D	16.7	2.99	2.05	32	31	2.113	21.67	0.3607
K	16.5	5.80	....	.....	.....	1.958	25.51	.....
G	15	4.36	6.90	32	30	2.188	16.80	.....
E	15	5.31	7.00	31	29	1.978	25.34	0.0630
I	10.0	20.36	1.10	32	30	2.123	15.11	0.464
M	9.5	28.20	0.65	.....	.....	1.910	34.92	1.234
P	8	23.67	....	.....	.....	1.924	21.15	0.7907
J	8	11.94	....	.....	.....	1.888	27.86	0.0350
F	3	12.51	2.80	.....	.....	1.910	20.56	0.1959
Carborundum:	24+	.....	....	.....	.....	.....	.....	.....

method and hence did not spall as much as they did in the first. For example, a brick which stood 1.8 heats when the furnace operated two heats per day, stood 22 heats when it operated two heats per day. Therefore, in Table I the values given for O, P, to S were found by multiplying the number of heats these brick withstood by $^{9}/_{11}$.

There appears to be a relation between the porosity of fire brick and their resistance to spalling and their serviceability (see Fig. 3). If a brick is too dense it cracks, due to differences in the expansion of its different portions. A more porous brick is less brittle and yields without cracking to these differences in expansion. When a brick is too porous, however, it also spalls readily. This may be due to the fact that porous brick lack mechanical strength and have a higher coefficient of expansion[1] as compared with the more vitreous brick.

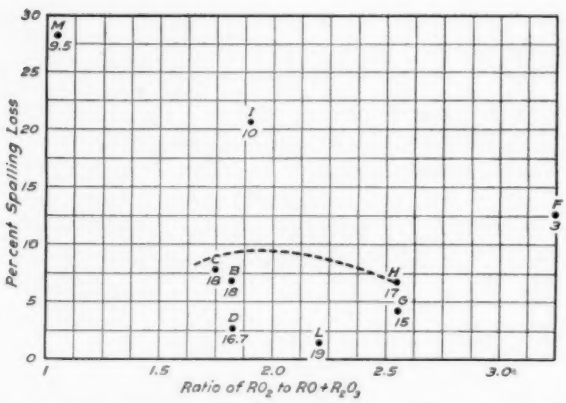

FIG. 4.—Relation between spalling losses and the RO_2 to $RO + R_2O_3$ ratios of fire brick and their serviceability.

Also corrosive gases and slags penetrate a porous brick more readily than a denser one, which would result in producing a more brittle brick and hence one which is more susceptible to spalling.

On examining the density and porosity data (see Table I and Fig. 3), it appears that brick give best service when their densities and porosities fall between certain limits. These should be neither too high nor too low. The brick giving best service had porosities between 15 and 28%, and densities between 1.9 and 2.3. Those brick whose porosities and densities were outside of this field gave comparatively poor service.

In examining the chemical analyses (see Table II and Fig. 4) it is evident that the RO_2 to $RO + R_2O_3$ ratio of the best brick lies between 1.5–2.6. If the RO_2 (*i. e.*, SiO_2) content is too high, too much free or uncombined silica is present, which increases spalling during heating and cooling, due to the volume changes during the transition of SiO_2 into its various forms at different temperatures. SiO_2 is also more vigorously attacked by the basic slags and gases than Al_2O_3.

[1] Rieke found that porous ceramic bodies in some cases had almost twice the coefficient of expansion of the same body when vitrified. R. Rieke, "Bestimmung der Wärmeausdehnung einiger Keramischen Massen," *Keram. Rund.*, **14**, 143–5 (1914).

TABLE II

CHEMICAL ANALYSES OF MALLEABLE-IRON FURNACE BUNG BRICK

No.	SiO_2	Al_2O_3	Fe_2O_3	CaO	MgO	Alkalies	$\frac{RO}{R_2O_3}$	$\frac{RO_2}{RO+R_2O_3}$	No. heats in malleable furnace bungs
L	54.73	39.25	2.10	0.05	0.05	1.10	2.30	2.21	19
B	52.20	43.42	2.18	0.40	0.40	1.47	1.98	1.83	18
C	51.04	41.04	2.17	0.65	....	4.48	2.05	1.75	18
A	52.93	42.69	1.98	0.33	0.38	1.55	2.04	1.89	17.5
H	58.36	28.76	8.20	....	0.30	3.02	2.93	2.57	17
D	52.60	43.22	2.00	0.40	0.30	1.69	2.01	1.84	16.7
K	54.65	41.36	2.02	0.48	0.29	1.12	2.18	2.03	16.5
G	58.36	28.76	8.20	....	0.30	3.02	2.93	2.57	15.0
E	52.16	43.71	1.98	0.41	0.30	1.68	1.96	1.82	15.0
I	53.75	41.50	2.06	0.39	1.75	....	2.14	1.91	10.0
M	38.40	56.75	2.95	trace	1.10	0.85	1.11	1.04	9.5
J	.....	.....	4.00	....	....	....	....	....	8.0
F	66.22	29.83	1.12	0.27	0.29	1.24	3.69	3.24	3.0
Carborundum	.....	.....	....	....	....	....	....	....	24+

Spalling tests were made on a number of different refractories to determine whether some other refractory was more resistant to spalling than fire clay brick. The results are given below:

TYPE OF REFRACTORY	PER CENT SPALLING LOSS
Fire brick clay	0.63–49.5
Carborundum brick	0
Magnesite brick	Lost over 90% after second quenching
Silica brick	Lost over 50% after second quenching

It is obvious that carborundum brick are much more resistant to spalling than the other refractories tested. Several bungs of carborundum brick were, therefore, tested in malleable iron furnace bungs.

One of the bungs stood up well after 24 heats, after which it was removed because of its high heat conductivity. This service is much higher than that of the fire clay brick tested. The second bung, however, broke the steel casing, due largely to the greater weight of the carborundum brick as compared with fire clay brick. The high heat conductivity of carborundum brick caused the outer surface of the brick to become red, thus allowing considerable loss of heat.

By designing special bung casings much stronger than those used, and by using an insulator between the iron casing and the carborundum brick to prevent heat losses, carborundum brick may prove to be an excellent refractory for malleable-iron furnace bungs because of their great resistance to spalling, and longer service. Carborundum brick, however, are much more expensive than fire clay brick.

The Utilization of Fire Clays for the Manufacture of Malleable-Iron Furnace Bung Brick

It was found in this work in general that a non-spalling brick gave best service in malleable-iron furnace bungs. A dense non-porous brick gave better results than a more porous brick, provided it was not so dense as to be brittle and thus increase the spalling tendency.

The above properties are governed largely by: (1) The selection of the proper clays, (2) the size of grain and the proportioning of the non-plastic to the plastic ingredients, (3) the fineness of grain of the bond clay, (4) the manner of molding, and (5) the temperature of firing.

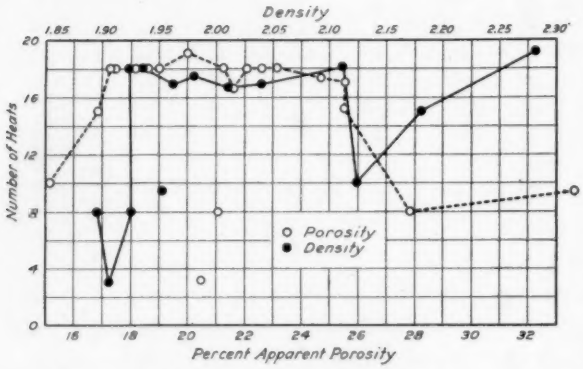

FIG. 5.—The relation between serviceability and the porosities and densities of fire brick.

The density and porosity of fire brick can be controlled by the proper selection of clays, and by proper firing. Some clays are porous when fired at high temperatures, while others are vitreous. By proper blending of these two types of fire clays, a mixture may be obtained, giving any desired porosity. The method of molding also affects the density and porosity of fire brick, as is shown below.[1] The following brick were made with 30 bond clay and 70 grog.

Method of molding	Per cent shrinkage	Per cent absorption	Compression strength, kg./cm.[2]
Soft mud	5.0	10.7	87
Soft mud and repress	4.9	9.6	88
Tamped brick	4.8	8.9	103
Dry press	5.1	12.7	50

These results show that a mixture with less water than soft mud consistency and with more water than dry press consistency produces the densest brick providing sufficient pressure is used in molding.

The size of grain and proportioning of flint clay[2] has a marked effect on the spalling tendency. Those brick containing a high percentage of coarse grog are more resistant to spalling than those containing fine-grained grog. A series of tests in which 1 x 1 x 8 inch bars were heated to

[1] "Verein deutscher Fabriken feuerfester Produckte," 1914.

[2] F. A. Kirkpatrick, *Trans. Amer. Ceram. Soc.*, **19**, 287 (1917).

600°C and quenched in water until they broke were conducted by Kirkpatrick on bars containing 50% bond clay and 50% grog. The average results obtained with the different series are given below and show that using coarse grog instead of fine increases the resistance of fire brick to spalling.

Size of grog in mixture	Number of quenchings before specimens broke due to spalling
4–20 mesh	11.1
8–20 mesh	9.3
12–80 mesh	7.5
20 dust	4.7

Increasing the percentage[1] of flint clay and reducing the percentage of bond clay increases the resistance of fire brick to spalling within certain limits.

The size of grain of the bond clay also affects the spalling tendency of fire brick. For example, it is shown in Fig. 7 that fire clay screened through a 20-mesh sieve is much more resistant to spalling than the same clay ground fine enough to pass a 150-mesh sieve.

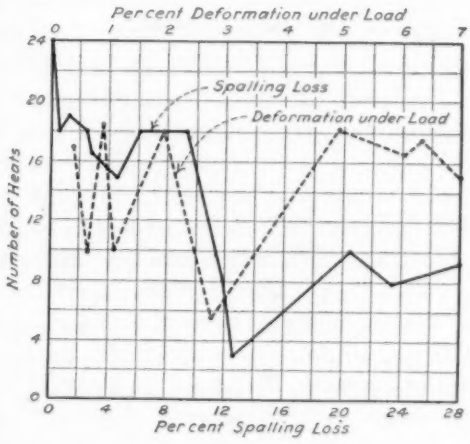

FIG. 6.

Different firing temperatures have a marked effect on the properties of fire brick. For example, it was found[2] that when clays of the fire clay type are fired to cone 8, they are often stronger than when fired to cone 6 or 10, even when the porosity and shrinkage data showed the bodies to be over or underfired at this temperature. Investigations on the effects of different firing temperatures[3] on the spalling tendency of fire clays and fire brick show that the firing temperature has an important effect on the spalling of the brick. Fire clay bars, 1 x 1 x 8 inches, previously fired to cones 6, 8 and 10, were heated to 600°C and plunged into water five times,

[1] R. M. Howe, "The Use of Plastic Clay Grog in Preventing Spalling," *Jour. Amer. Ceram. Soc.*, **4** [2], 119 (1921).

[2] H. G. Schurecht, "Notes on the Effects of Firing Temperatures on the Strength of Fire Clay and Stoneware Bodies," *Jour. Amer. Ceram. Soc.*, **4** [5], 366–74 (1921).

[3] "The Properties of Some Stoneware Clays," U. S. Bureau of Mines, *Tech. Paper* **233**, 26 pp. (1920); R. M. Howe and R. F. Ferguson, "A Study of Spalling," *Jour. Amer. Ceram. Soc.*, **4** [1], 40 (1921).

after which their strength was measured. The strengths of those bars which had been fired to cone 8 were higher after the quenching treatments than those fired to cone 10 and in some cases they were stronger than those fired to cone 6 (see Fig. 7).

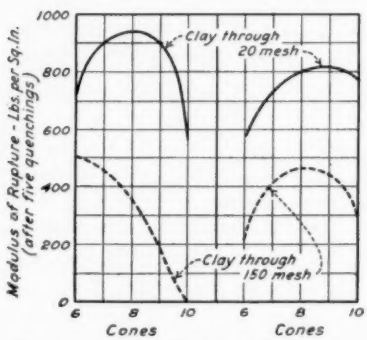

FIG. 7.—The effects of firing temperatures and fineness of grain of fire clays on their resistance to spalling.

It appears, therefore, that by firing brick to cone 8, a product is often obtained which is more resistant to spalling than when fired to cone 10. This may be due to the presence of sillimanite and free silica in the fire brick, which are formed at high temperatures.

Summary

The work on malleable-iron furnace bung brick, which has been done up to the present time, has not been extensive enough to draw definite conclusions. The writer, however, offers the following summary, which applies only in so far as the work has progressed:

Fire brick for malleable-iron furnace bungs should be strong enough to support the arch at high temperatures, but it is not necessary that the brick should stand as high a load test and fusion test as are required for No. 1 fire brick. Fire brick which may deform as much as 6.35% in the load test may be very serviceable as bung brick in malleable-iron furnaces.

Although brick which pass very high load and softening point tests often give good service in practice, many which pass these tests fail.

The spalling test bears the closest relation to the service test. When the spalling loss was above 10%, the number of heats which the corresponding brick withstood in practice was below 15. In general, brick showing a spalling loss below 10% withstood 15 or more heats in practice.

The brick giving best service had porosities between 15 and 28% and densities between 1.9 and 2.3.

The RO_2 to $RO + R_2O_3$ ratios of the best brick were between 1.5 and 2.6.

Carborundum brick withstood more heats than any fire clay brick tested, but are objectionable due to their high heat conductivity and greater weight. These objections, however, can be overcome by using heat insulation and stronger casings.

In the manufacture of malleable-iron furnace bung brick, their properties may be governed by (1) the selection of the proper clays, (2) the size of grain and the proportioning of the non-plastic and plastic ingredients, (3) the fineness of grain of the bond clay, (4) the manner of molding, and (5) the temperature of firing.

NOTE:—In conclusion, the author wishes to acknowledge his indebtedness to J. M. Kittle of the Ohio Malleable Iron Company, and J. S. McDowell of the Harbison-Walker Company, for their coöperation in this work.

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Discussion

C. E. BALES:—This paper is a valuable contribution not only to the user of refractories, but also to the manufacturer. We fully agree that the load test is of no value in determining the quality of bung brick as we know of brick deforming as much as 8.7% in this test, which gave excellent service.

In our work the brick showing the least spalling loss has always given the best results in actual service. We have found that brick with a high fusion point (cone 33), iron oxide content less than 2.5% and alumina between 40 and 45% have stood up best in service. Brick high in silica (68%) gave only 4 heats in service, the failure being due to spalling.

Our experience agrees with Mr. Schurecht's opinion that the porosity of fire brick is an important property and that bung brick will fail if they are too porous as well as if they are too dense.

We were surprised to learn that bung brick with 8.20% Fe_2O_3 would give 17 heats in a malleable-iron furnace.

It is doubtful if carborundum brick will ever be used extensively in malleable-iron furnaces on account of their high cost, high heat conductivity, their weight, and the fact that they begin to dissociate at about 2725°F under oxidizing conditions and at about 3100°F under reducing conditions.

A PROPOSED METHOD FOR STUDYING THE ATTACK OF MOLTEN SLAGS AND GLASSES UPON REFRACTORY MATERIALS[1]

By Charles I. Rose

ABSTRACT

A new method of studying the attack of molten glasses and slags upon refractory materials, whereby the refractory tested is rotated in a glass or slag melt under arbitrary conditions, is described. The solution and penetration of the refractory are measured separately by means of a micrometer and simple microscope, and some of the advantages of this procedure are enumerated.

Introduction

The action of molten slags or glasses upon refractory materials is a consideration of prime importance.

There are two general and distinct phases into which the attack of these glasses or slags may be divided. These are (1) the solution or removal of a portion of the refractory body causing a shrinkage of dimensions of the original piece, and (2) the penetration of the remaining material. The combined effects of simple solution, chemical reactions between the body and molten liquid, and the abrasive action of the slag or glass upon the refractory are gathered together under the first division. Penetration on the other hand is used to refer to such action of molten liquids upon the bodies which does not result in any reduction of the dimensions of the materials. The filling of the pores of a refractory below its surface illustrates this.

Any method whereby the action of molten substances upon refractories is to be studied should (1) permit easy differentiation to be made between the two phases of the attack as listed above, (2) be simple, and adaptable to various conditions, (3) give quantitative results, (4) preserve the characteristics of the material to be tested instead of destroying them previous to or during a test.

Some previously published methods of studying this attack are listed below.

E. A. Coad-Pryor[2] investigated the solution of glass pot mixtures in various glasses. His method consisted of making small rods of the material to be used, and then immersing them in a small pot containing the molten glass. After a given period of immersion the rod was withdrawn, and the effect of solution noted. The results were purely relative.

G. H. Brown[3] used a somewhat similar procedure to the above. He

[1] The following paper describes a method used by the author in preparation of a thesis which partially fulfilled the requirements for the degree of Master of Science in Ceramics at the University of Illinois.

[2] E. A. Coad-Pryor, "Notes on Pot Attack," *Jour. Soc. Glass Tech.*, **2**, 285 (1918).

[3] G. H. Brown, "A Method of Testing the Corrosive Action of Slags on Fire Brick," *Trans. Amer. Ceram. Soc.*, **18**, 277 (1916).

immersed a brick of the refractory material in a box or sagger of molten glass. After a definite period of immersion the box was cooled, and the brick broken from the solidified mass, and the results noted. The results are also relative.

The American Society for Testing Materials[1] has adopted a tentative standard for studying the slagging action of refractories. The method consists in melting synthetic slag within a fire-clay ring placed on the surface of the refractory. The slag is maintained in a molten condition for a certain period at a definite temperature. After cooling, the brick is sawed through the middle of the ring, and the area of penetration of the slag is measured by means of a planimeter. The results are very indefinite.

Recently R. M. Howe[2] in an article discussing the phases of slag attack gives some data based upon results obtained by allowing a molten slag to seep into the refractories used, and then noting the penetration.

As a continuation of the above he has, with the coöperation of Howe, Phelps and Ferguson[3] presented a later article dealing with the dissolving action of the slag on the refractory. In this procedure the refractories are ground to pass a certain mesh, mixed with varying proportions of the slag used, molded in the shape of cones, and the melting points of these cones determined. In this test the texture and some of the physical characteristics of the refractory are destroyed previous to the test.

Accelerated Slag Test

The purpose of our investigation was to devise an accelerated test without increasing the temperature above that used in ordinary practice. The advantage of this procedure is that any compounds present in the refractory which are stable at practical operating temperatures are preserved, whereas a higher temperature might destroy them, and so give the refractory the appearance of having properties which it did not actually possess under ordinary operating conditions. Briefly, the proposed method consisted in rotating cylinders of the refractory material in a pot of glass under conditions which should be as nearly reproducible as possible for the various refractories in relation to each selected glass. After rotating the cylinder in the molten glass for a desired period, the solution and the penetration were measured by means devised for this process, and the results were expressed in a definite manner.

[1] *A. S. T. M. Tent. Stand.*, 293 (1922).

[2] R. M. Howe, "A Study of the Slag Test," *Jour. Amer. Ceram. Soc.*, **6** [2], 466 (1923).

[3] R. M. Howe, S. M. Phelps and R. F. Ferguson, "Action of Slag upon Silica, Magnesite, Chrome, Diaspore and Fire-clay Refractories," *Jour. Amer. Ceram. Soc.*, **6** [4], 589 (1923).

Abrasion and Chemical Reaction.—The two most influential factors in producing solution of a given refractory body are the abrasive effect caused by the rotation of the cylinder in the molten glass, and the chemical reactions taking place between the refractory material and the glass. The abrasive action of the glass or slag will vary directly with the rate of rotation, while the chemical effects will depend upon the differences in chemical characteristics between the two materials at the temperature of operation of the test. The former can be controlled at any time, but the latter can be controlled only by changing the temperature or altering the glass composition. Simple solution will also have an effect, but this will probably be very small in connection with the two mentioned above. In any case the solution measured is the total amount regardless of the manner in which it was produced.

Viscosity of Glass.—The factors influencing the penetration of the body are the viscosity of the glass or slag, the porosity of the body tested, and the size of pores in that body. The viscosity of the molten mass can be altered at will within limits by changing the temperature, but the porosity and the size of pores of the refractory body depend upon the preparation of the body, and are uncontrollable insofar as the test is concerned.

The factors in the test which can be altered at will are the rate of rotation of the cylinder, the length of time employed in the test, the kind of slag or glass used, and its viscosity which is dependent upon the temperature selected.

Apparatus Used.—A platinum resistance furnace was used for the tests. The heating element was wound around a grooved clay pot which was well insulated. A smaller clay pot containing the glass was placed in the first pot. These pots were made to fit snugly, but to prevent any rotation of the inner pot it was lightly cemented to the outer one with some plastic clay. A thermocouple inserted between the walls of the two pots allowed the temperature to be read. The usual ammeter, voltmeter and rheostats were employed. A fuse was placed in the line as an extra precaution so that if any short circuits took place by accident in the heating element, the fuse would blow before the platinum wire would be melted. Close control of the furnace temperature was possible as compared to practice. Variation in the temperature was usually 10°, and never varied over 15°.

The furnace was placed upon a platform which could be raised or lowered by means of a screw and threaded ring. Above the furnace was a support for the rotating device. The top of the support held a platform made of asbestos board through a hole in which the rotating shaft passed. The driven pulley was fastened to the upper end of this shaft, and to the lower end was secured a collar having a number of set screws in which the spindle

holding the cylinder was fastened. A small constant speed motor operating through a series of reducing gears rotated the spindle.

Procedure.—The glass cullet used was melted in the furnace while it was in the lowered position. All glasses had previously been prepared in a separate furnace. The refractory cylinder, the average diameter of which had also been measured at a certain point, was inserted in the spindle, and that in turn in the collar, and then the furnace was raised until the cylinder was well immersed in the molten glass. Since the introduction of the comparatively cold cylinder into the glass chilled it, some minutes' wait was necessary to restore the temperature of the glass. After the temperature had been regained the piece was then started rotating at the desired speed.

When the test had continued as long as desired the furnace was lowered with the cylinder rotating until entirely clear of the surface of the glass. A thread of glass formed between the end of the piece and the surface of the glass which could be broken easily by a sharp rap with some tool. The cylinder was then removed from its holding device with a uniform coating of glass, and placed while hot in a heated drier to cool slowly. After cooling the necessary measurements were made.

Measurements.—Before the test the average diameter of the burned cylinder in a given plane on its length was determined by taking the mean of a number of diameters in that plane. The location of the plane was noted definitely.

After the test the piece was cut through by means of a thin cut off wheel at the point established. This gave a plane face on the end of the cylinder. The center of this circle was established by noting the point of intersection of lines joining the points of tangency of the two parallel jaws of a caliper across the face of the cylinder. This point was further checked by measuring from it to other points on the circumference of the piece. After having found the center then any straight line through it was necessarily a diameter.

The piece was then set with this flat surface directly under the tube of a simple microscope and it was brightly illuminated. The established center was placed directly under the intersection of the two fixed cross hairs in the ocular of the microscope, and the cylinder was held successively in such positions that the travel of the microscope tube across the face through the established center was the trace of the previously measured diameters.

The distance traveled was measured by subtracting the two lengths of supporting rod extending from a fixed part of the microscope's structure which were necessary to bring the cross hair directly over the line of demarcation between the glass and body at the ends of a selected diameter.

The penetration could be measured by means of a calibrated traveling

cross hair in the ocular. The depth could be easily observed under the microscope.

Measurements were made with a wide-jawed micrometer graduated to ten-thousandths of an inch. In all cases the division line between the glass and body stood out distinctly when illuminated, and very accurate settings of the cross hair were possible.

It was also found that the method of cutting off the end of the cylinder by means of a thin grinding wheel was very satisfactory. The glass adhering to the cylinder, though cracked due to the cooling of it under these conditions, nevertheless adhered firmly to the body. The cutting process did not chip it off as might be expected which would be the case if an attempt were made to grind the cylinder down against a large wheel.

Since the rate of removal of the refractory from the glass, and also the rate of insertion into it could be controlled as desired any tendency to spall on the part of the refractory was counteracted. However, this could be made the basis of a slightly modified spalling test.

Results

The solution of the body was expressed as the rate per day in inches at which it took place. The unit employed is purely arbitrary. It is to be noted in connection with the solution as affected by the rate of rotation that a definite rate of rotation refers to a definite linear velocity of a point on the circumference of any given cylinder. Since the diameters of the cylinders varied it was necessary to calculate the revolutions per minute necessary for each piece to give a selected linear velocity. This latter figure could be selected as desired.

The penetration of the molten glass or slag was measured and noted in inches. As no methods of measuring the sizes of pores in the body, or of ascertaining their number and distribution easily were available this was the only manner in which to express the result. However, results so far obtained show that if the porosity of the pieces tested is known, then the relative sizes and numbers of pores could be determined in comparison with another body due to differences of penetration under the same conditions. In other words if a body of high porosity shows less penetration than one of lower porosity when tested under identical conditions, then the first material had smaller pores, and penetration by the molten glass was more difficult than in the second case.

Investigations of various types of refractory materials are being carried out now in the Laboratory of the Department of Ceramic Engineering at the University of Illinois by means of this method, and results already obtained seem to indicate that the procedure outlined above has certain advantages over others which have been previously proposed.

Summary.—The procedure described above for studying the attack of

molten glasses and slags upon refractory bodies promises to give a method which will (1) permit the solution and penetration of the refractory by the glass or slag to be easily distinguished and measured, (2) give quantitative results, and be very accurate, (3) employ simple apparatus which is readily constructed, and such as will permit the general plan of the method to be executed, (4) not destroy the peculiar characteristics and properties of the refractory previous to or during the test, (5) require no special precautions to perform, (6) give the relative size of pores in the body when the porosity is known, and (7) permit a wide variation in conditions any of which may be fixed as desired for any particular investigation.

NOTE:—The author wishes to express his indebtedness to C. W. Parmelee who suggested the general method of attack, and gave much valuable advice.

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THE ORIGIN, DISTRIBUTION AND COMPOSITION OF LATERITE

By C. O. Swanson

ABSTRACT

The term laterite means a red rock or red earth deposit. Laterites are formed by the decomposition of different kind of rocks, under conditions yielding aluminum and iron hydroxides. The different theories of origin are discussed, as well as the chemical process of laterization, and the geographic distribution of this peculiar type of clay.

Introduction

The term laterite comes from the Latin word *later* meaning brick or tile, and was first suggested by Buchanan,[1] because the prevailing color of laterite is red and they are quite commonly hard.

The term laterite includes a variety of materials. Clarke[2] defines laterite as essentially a mixture of ferric hydroxide, aluminum hydroxide and free silica in varying proportions. Dixey[3] defines laterite as a rock of variable composition, consisting of the hydrated oxides of iron, aluminum, titanium and rarely manganese. La Croix's definition of laterite as reported by Fermor[4] is: "The products of decomposition of all siliceous and aluminous rock, characterized from a chemical point of view by the predominance of hydroxide of aluminum and iron, generally with titanium oxide."

According to La Croix[5] the term laterite should be restricted to the products of decomposition of diabase, gabbros and especially to materials of light color such as result from the transformation of granites and syenites. Red color is not to be considered a specific of laterite.

Clay is a hydrated aluminum silicate while laterite is a mixture of oxides more or less hydrated.[6] These mixtures of hydrated oxides are extremely variable in composition, some are almost free from iron, others are almost free from alumina. Some laterites are used as an iron ore and others as aluminum ore. Warth and Warth[7] say that laterite is bauxite in various degrees of purity, from the richest wocheinite down to such specimens in which the free alumina has entirely disappeared.

Laterite is not a simple substance but a material which may differ widely in chemical composition and physical characteristics, and yet the material

[1] Buchanan, "Manual of the Geology of India," 348 (1879); 349 (1881).

[2] F. W. Clarke, "Data of Geochemistry," U. S. Geol. Surv., *Bull.* **616,** 493–501 (1916).

[3] F. Dixey, "Notes on Laterization in Sierra Leone," *Geol. Mag.*, **57,** 211–220 (1920).

[4] L. L. Fermor, "The Work of Professor La Croix on the Laterites of French Guiana," *Geol. Mag.*, **2,** 28–37, 77–82, 123–129 (1915).

[5] A. La Croix, "Les Produits des Roches Silicate set Alumineuses, et en Particulier les Laterites de Madagascar," *Compt. rend.*, **159,** 617–622 (1914).

[6] L. L. Fermor, "What is Laterite?" *Geol. Mag.*, **8,** 454–462; 507–516 (1911).

[7] H. Warth and F. J. Warth, "The Composition of Indian Laterite," *Geol. Mag.*, **10,** 154–159 (1903).

must have certain properties and characteristics in order to be classed as a laterite.

Distribution of Laterites

Many writers believe that laterites are a product of tropical conditions. As tropical conditions have not always been confined to the tropics of the present day laterites may be found in the higher latitudes. Laterites are widely distributed geographically but occur in the largest amounts in the tropics.

The laterites of India are described by Fermor,[1] Holland,[2] Maclaren,[3] Warth and Warth,[4] Fox,[5] Lang,[6] Dunstan,[7] and others. The work of Baur[8] on the laterites of Madagascar and Seychelle Islands, and of La Croix[9] on the laterites of French Guiana and Madagascar are from the standpoint of completeness of the greatest importance. Besides these, laterites from the following localities have been studied: Sierra Leone,[10] Mozambique,[11] British Guiana,[12] West Africa,[13] West Australia,[14] New Caledonia,[15] Sudan and Congo,[16] Rhodesia,[17] East Africa,[18] Malay Penin-

[1] L. L. Fermor, "Manganese in Laterite," *Memoirs of the Geol. Surv. of India.*

[2] T. H. Holland, "On the Constitution, Origin and Dehydration of Laterite," *Geol. Mag.*, **10**, 59–69 (1903).

[3] Malcolm Maclaren, "On the Origin of Certain Laterites," *Geol. Mag.*, **3**, 537–547, (1906).

[4] H. Warth and F. J. Warth, *loc. cit.*

[5] Cyril Fox, "The Bauxite Resources of India," *Mining Mag.*, **26**, 82–96 (1922).

[6] Richard Lang, "Geologisch—Mineralogische Beobachtungen in Indien," *Centralblatt für Mineralogie*, 641–653 (1914); 148–160 (1915).

[7] W. R. Dunstan, "Report on Laterite from the Central Provinces, India," *Record Geol. Surv., India*, **32**, 213–220 (1903–1904).

[8] Max Baur, "Beirtag zur Kenntniss des Laterits, insbesondere dessen von Madagascar Neues Jahrbuch für Mineralogie, Geologie und Paläontologie," *Festband*, 33–90 (1807–1907).

[9] A. La Croix, "Les Laterites de la Guinée et les Produits d'Alteration qui leur sont Associates," *Nouvelles Archives du Musee*, **5** [5], 255–356 (1914).

[10] F. Dixey, *loc. cit.*

[11] T. H. Holland, *loc. cit.*

[12] J. B. Harrison, "Laterites in British Guiana," *Geol. Mag.*, **7**, 439–452; 488–495; 553–562 (1910).

[13] J. Morrow Campbell, "The Origin of Laterite," *Trans. Inst. Mining and Metallurgy*, **19**, 432–435 (1909–1910).

[14] W. G. Woolnough, "The Physiographic Significance of Laterites in Western Australia," *Geol. Mag.*, **5**, 385–393 (1918).

[15] W. M. Davis, "Metalliferous Laterites in New Caledonia," *Proc. Nat. Acad. Sci.*, **4**, 275–280 (1918).

[16] H. Arsandaux, "Laterite Formation," *Compt. rend.*, **149**, 682–685, 1083–1084 (1909); *C. A.*, **4**, 888 (1910).

[17] F. P. Mennel, "Notes on Rhodesian Laterite," *Geol. Mag.*, **6**, 350–352 (1909).

[18] L. L. Fermor, *loc. cit.*

sula,[1] and laterite from Ceylon, China and Caucasia.[2] The laterites of South America have been comparatively little studied, although they are probably the most important in the world.[2]

If it is accepted that bauxites are laterites especially rich in alumina, then, it follows that there are deposits of laterites in the temperate climates. The bauxite deposits of Arkansas,[3] Georgia,[4] and Alabama, show similarities to many laterites. Kilroe[5] describes a deposit in Vogelsberg, Germany, which is very much like laterite and also like bauxite. The similarities in chemical composition of laterites and bauxites, can be seen by studying the figures given in Tables I–VII.

A hard crust overlying the laterite seems to be common. It is not seen in gibbsitic laterite. The hardness is invariably increased on exposure to the air.[6] Harrison[7] ascribes the cause of hardening in part to changes in the degree of hydration of the hydrated oxides of iron and aluminum, and the gradual conversion of soluble colloidal forms to insoluble ones. Hardening of the lateritized surface is a usual but not a necessary accompaniment of laterite formation.

Rocks Which Furnish Materials for Laterite Formation

Laterite may be formed from several kinds of rock. Baur[2] gives analyses of laterites derived from granite, diabase amphibolites and sandstone, and Lenz[8] gives analyses of laterites formed from clays and sandstone. Laterite occurs over basalt and gneiss of different varieties.

According to Harrison[7] rocks in which plagioclase feldspar are abundant with their usual concomitants of ferromagnesian minerals, form laterites by decomposition *in situ*. Rocks in which alkali feldspars predominate as a rule decompose into kaolins.

It appears that the process of laterization has more to do with the character of the laterite formed, than the nature of the parent rock. It is evident that the rock must contain the necessary content of aluminum and iron. The relation between the parent rock in one region may not be the same as in another region which is widely different in climate and physiography.

[1] L. H. Fermor, *loc. cit.*

[2] Max Baur, *loc. cit.*

[3] W. J. Mead, "Bauxite Deposits in Arkansas," *Econ. Geol.*, **10**, 28–54 (1915).

[4] T. L. Watson, Georgia Geol. Surv., *Bull.* **11**.

[5] J. R. Kilroe, "On the Occurrence and Origin of Laterite and Bauxite in the Vogelsberg," *Geol. Mag.*, **5**, 534–542 (1908).

[6] J. Morrow Campbell, *loc.cit.*

[7] J. B. Harrison, *loc. cit.*

[8] Rudolph Lenz, "Chemische Untersuchung über Laterit," Inaug.-Diss. Freiburg i Br., 45 (1908); Referat Max Bauer, "Neues Jahrbuch für Mineralogic," *Geologie und Paläontologie*, **2**, 347 (1909).

Laterization as Affected by Climate

Laterites have arisen from the decomposition of aluminous minerals by changes that seem peculiarly characteristic in the tropics,[1] due to the action of the tropical forest on the soil.[2] Laterite deposits are restricted geographically because they require for their formation tropical heat, heavy rainfall and luxuriant vegetation.[3] They also require wet and dry seasons,[4] and elevated plains on gently sloping land surfaces not subject to appreciable erosion. Harrison[5] claims the evidence does not prove that the production of laterite is confined to hot, moist climates. He admits, however, that the preservation of the laterite deposits is largely confined to tropical countries, as under temperate conditions of denudation, detrition and lack of hardening the accumulation of laterites *in situ* to a great depth would be impossible.

Holmes[6] observes with reference to the laterites of Mozambique that none occurred at the surface where the forest and undergrowth were thick. The deposit was almost always associated with areas where the superficial layer was clean, free from organic matter and so-called humous acids. This observation is not so contradictory as would first appear. The laterites may have been formed under forest conditions, but since their formation the vegetation has perished.[2]

Campbell[7] says that luxuriant vegetation and tropical temperatures are advantageous but not indispensable. Lang[8] observes that the laterites of India are found only under the brown and humous soil, and all evidence points to the fact that laterite is a fossil deposit, belonging to a past period of dry climate. Mead[9] thinks that one reason why laterization has largely been confined to the tropics is that through the action of frost, the open cellular structure is destroyed, allowing the clays to slump and become impervious, thus checking further alteration of clays in regions subject to frost. It seems that an open cellular structure, or at least porosity, is one of the essential conditions for laterization to take place on an extensive scale.

Holland's[10] theory of the origin of laterite differs from all others. Ac-

[1] Max Baur, *loc. cit.*

[2] Malcolm Maclaren, *loc. cit.*

[3] H. Stremme, "Die Entstenhung des Laterits," *Zeits. der Gesell. für Erd kunde zu Berlin*, **2** (1917); Biederman's *Zentralblatt für Agr. Chemie*, **48**, 51–52.

[4] Cyril Fox, *loc. cit.*

[5] J. B. Harrison, *loc. cit.*

[6] Arthur Holmes, "The Laterite Deposits of Mozambique," *Geol. Mag.*, **1**, 529–537 (1914).

[7] J. Morrow Campbell, *loc. cit.*

[8] Richard Lang, *loc. cit.*

[9] W. J. Mead, *loc. cit.*

[10] T. H. Holland, *loc. cit.*

cording to this investigator, laterite formation is due to the agency of lowly organisms, possibly akin to nitrifying bacteria. Holland claims that this theory would account for the following facts: (*a*) Laterites are most extensively developed under tropical conditions; (*b*) Although laterites may be 100 or more feet in thickness there is a sharp change from the soft decomposed product to the absolutely fresh rock below; (*c*) That though laterites can form in temperate climates, the seasons of cold are inimical to these microörganisms; (*d*) Laterite is a superficial product.

From most observations, it appears that a hot, moist climate is a favoring condition if not an absolute necessity. Bauxites are found in comparatively few places in the higher latitudes.

The General Process of Laterite Formation

When a rock is converted into laterite,[1] the silicates are decomposed and the silica is removed in solution. While the oxides of iron and aluminum are relatively soluble under clay forming conditions, they are relatively insoluble under laterite forming conditions. The oxides of calcium, magnesium, sodium and potassium are soluble under both sets of conditions. From this it is not concluded that aluminum is insoluble. Under conditions of laterization it is capable of entering into solution and being redeposited as aluminum hydrate when the conditions are favorable.

In general the chemical process of laterization means the elimination of the alkalies, alkaline earths, and silica from the original rock, and the persistence of the hydrated oxides of aluminum and iron with a small amount of titanium oxide. The aluminum is left chiefly in the form of hydrargillite and the iron as hydrous oxide.

Laterization Compared with Kaolinization

The chemical equation for the production of kaolinite from feldspars, an essential process in the formation of clay, may be written: $K_2O.Al_2O_3.6SiO_2 + CO_2 + 2H_2O = Al_2O_3.2SiO_2.2H_2O + K_2CO_3 + 4SiO_2$.

The equations given by Cameron and Bell[2] showing hydrolysis followed by splitting off of silica are as follows:

$$KAlSi_3O_8 + HOH = KOH + HAlSi_3O_8$$
$$HAlSi_3O_8 - SiO_2 = HAlSi_2O_6 \text{ Pyrophylite}$$
$$HAlSi_3O_8 - 2SiO_2 = HAlSiO_4 \text{ Kaolinite}$$
$$HAlSi_3O_8 - 3SiO_2 = HAlO_2 \text{ Diaspore}$$

The equation for the production of laterite as adapted from Maclaren[3] may be written:

[1] L. L. Fermor, *loc. cit.*

[2] Frank K. Cameron and James B. Bell, "Mineral Constituents of the Soil Solution," U. S. Dept. of Agriculture, Bur. Soils, *Bull.* **30.**

[3] Malcolm Maclaren, *loc. cit.*

$$K_2O.Al_2O_3.6SiO_2 + 3H_2O + CO_2 = 2Al(OH)_3 + K_2CO_3 + 6SiO_2$$

These equations show that chemically the processes of kaolinization and laterization are similar, the latter being a further step in the elimination of silica from the weathered product.

In laterization all the minerals produced are in a state of hydration either colloidal or crystalline and most often the two together.

The work of Kahlenberg and Lincoln[1] has shown that silicates in contact with water produce colloidal silicic acid.

$$Na_2SiO_3 + \text{water} = 2\,\overset{+}{Na}, \overset{-}{OH} + \text{colloidal silicic acid}$$

$$Na_2Si_5O_{11} + \text{water} = 2\,\overset{+}{Na}, \overset{-}{OH} + \text{colloidal silicic acid}$$

This chemical process has a most important bearing on laterite formation where one of the essential processes is the removal of silica which would be carried away in colloidal form by water.

Titanium in Laterite

Titanium is the element which suffers the least loss in the transformations which produce laterite. It is usually present in the form of rutile, TiO_2, or as ilmenite, $FeTiO_3$, or titaniferous magnetite. The first two may be produced from sphene according to Van Hise.[2]

$$CaTiSiO_5 + CO_2 = CaCO_3 + TiO_2 + SiO_2$$
$$TiO_2 + FeCO_3 = FeTiO_3 + CO_2$$

The tables which follow show that titanium is present in many laterites in considerable amounts.[3] Titanium is found not only in bauxites and laterites, but it is also present in most soils.[4]

Zone of Leaching and Zone of Concretion

La Croix[3] introduces two descriptive terms which help to clarify our ideas regarding laterite formation. These are "Zone of Leaching" and "Zone of Concretion."

Zone of Leaching.—"This zone is characterized by the elimination of the greater part of the constituents, whose removal characterizes the phenomena of laterization. Three cases can be distinguished, marked by the formation of gibbsitic laterites, ferruginous laterites and bauxitic laterites, respectively."

[1] Louis Kahlenberg and A. T. Lincoln, "Solutions of Silicates of the Alkalies," *Jour. Phys. Chem.*, **II**, 77–90 (1898).

[2] C. R. Van Hise, "In Treatise of Metamorphism," U. S. Geol. Surv., *Monograph* **47**, pp. 227 (1900).

[3] L. L. Fermor, *loc. cit.*; A. La Croix, *loc. cit.*

[4] F. P. Dunnington, "Distribution of Titanic Oxide upon the Surface of the Earth," *Amer. Jour. Sci.* (*Silliman's*), **142**, 491–495 (1891).

Zone of Concretion.—In this zone the leaching is carried to a finish and it is characterized by migration of iron to the surface accompanied by the separation of iron and aluminum hydroxides. The iron sometimes accumulates in sufficient amounts to constitute an iron ore. There are

TABLE I

ANALYSES OF FRESH ROCK AND RESULTING LATERITES

Constituents	Fresh rock nepheline syenite, per cent	Resulting Laterite: Zone of leaching, porous gibbsitic laterite, per cent	Resulting Laterite: Zone of concretion, compact gibbsitic laterite, per cent	Resulting Laterite: Zone of leaching, clay, gibbsitic, per cent
SiO_2	56.88	2.21	0.37	35.14
TiO_2	0.29	0.12	0.90	0.70
Al_2O_3	22.60	55.83	57.12	40.12
Fe_2O_3	0.97	5.22	7.41	4.12
FeO	2.19	....	....	....
CaO	1.33	0.24	0.17	0.45
MgO	0.56	0.19	....	0.21
Na_2O	8.30	0.49	0.26	....
K_2O	5.57	0.27	0.37	....
P_2O_5	0.08	....	....	....
H_2O	0.98	30.47	33.71	17.84
Insoluble	0.34	5.74	0.30	1.46

Constituents	Fresh rock diabase, per cent	Resulting Laterite: Zone of leaching, porous argillaceous gibbsitic laterite, per cent	Resulting Laterite: Zone of concretion, compact gibbsitic laterite, per cent	Fresh rock peridotite, per cent	Resulting Laterite: Zone of leaching, porous argillaceous ferruginous laterite, per cent	Resulting Laterite: Zone of concretion, ferruginous laterite iron ore, per cent
SiO_2	51.27	5.83	1.30	38.32	12.67	....
TiO_2	0.70	1.29	1.03	0.28	0.55	....
Al_2O_3	12.36	37.03	60.19	2.66	12.59	4.80
Fe_2O_3	3.29	31.73	3.91	4.35	46.84	83.50
FeO	6.16	....	....	11.78	....	....
CaO	10.66	0.19	0.17	2.74	0.04	....
MgO	13.26	0.06	....	36.22	1.26	....
Na_2O	1.60	....	....	0.16	....	....
K_2O	0.41	....	....	0.06	....	....
P_2O_5	0.11	....	....	....	....	....
H_2O	0.40	23.02	32.00	3.38	15.32	10.18
Insoluble	....	0.96	1.40	....	10.73	1.70

several types of end products resulting from the completion of the process of laterization in the zone of concretion, as described below:

1. Gibbsitic type: Chemical analyses and microscopic examination prove that gibbsite migrates nearly as much as does iron hydroxide. Gibbsite is rather soluble in underground waters as is evident from the presence

of this crystalline mineral in geodes and in cracks of laterites and ores from different parts of the tropics. "The final result of the transportation and recrystallization of gibbsite is its formation of granular crystalline rocks of relatively coarse grain composed almost entirely of gibbsite."

2. Ferruginous types: In the laterites derived from peridotites the zone of concretion corresponds with the ferruginous crust. All varieties of limonite, stilpnosiderite, and red tints indicating hematite are seen.

3. Bauxite types: Bauxite types are characteristic of laterites from gneisses, granites and mica schists. The aluminum hydrate, which little by little replaces the aluminum silicate, assumes at first the colloidal form. "It is always accompanied by an important and often prominent proportion of colloidal hydrates" and "this crystalline mineral is a product of transformation of colloidal."

4. Pisolitic laterites: Pisolitic laterites are a very characteristic form. These have been formed *in situ* in a medium in a state of rest, and in general have not suffered transport since their formation. Their form, degree of regularity, and size depend on the physical state of this medium. The best condition for the formation of pisolites is the existence of a homogeneous medium inclosing few or no solid elements unsusceptible of concretionary rearrangement unless in small grains. This explains the abundance of pisolites in the laterite crusts of mica schists, clays and alluvium.

Composition of Laterite Compared with the Parent Rock

La Croix,[1] gives the composition of nepheline syenite, diabase, and peridotite together with the laterites resulting from these rocks.

These figures show that laterites derived from the same kind of rock vary in composition, depending from what zone the analyzed sample is

TABLE II

COMPARISON OF PARENT ROCK AND LATERITES

Constituents	Diabase, per cent	Laterite, per cent	Hornblende schist, per cent	Laterite, per cent
Quartz	3.20	47.35	7.60	32.51
Colloidal Silica	....	0.06	....	....
Combined Silica	47.99	3.30	44.10	14.93
Al_2O_3	15.80	26.33	15.94	34.14
Fe_2O_3	14.28	18.93	14.40	7.64
MgO	5.63	0.21	5.54	0.11
CaO	9.58	0.23	9.60	0.01
Na_2O	2.09	0.14	1.87	0.53
K_2O	0.60	0.21	0.08	0.48
H_2O	0.30	11.28	0.30	9.00
TiO_2	0.40	0.61	0.30	0.90
P_2O_5	0.008	trace	0.01	0.02
Mn_3O_4	....	....	....	....

[1] L. L. Fermor, *loc. cit.*

taken. The large loss of silica and the persistence of titanium is evident. There is an enrichment of aluminum and iron in all cases, but where the enrichment of iron is large, that of aluminum is correspondingly small. The greater part of the alkalies and alkaline earth disappears in the process of laterite formation. A large enrichment in aluminum is followed by a large degree of hydration, and when iron predominates over the aluminum the degree of hydration is less.

Harrison[1] gives the composition of some laterites from British Guiana, together with the parent rock. See Table II.

In these laterites a large amount of quartz is present apparently in a free condition. While the chemical process of laterization sets silica free, it does not necessarily remove the silica from the laterite. Whether silica shall be removed seems to depend on the mode of motion of the water.

Composition of Various Laterites

Warth and Warth[2] give the composition of a number of Indian laterites which they divide into four groups as follows: 1. Laterites which are very low in iron, very high in aluminum and have a very small amount of quartz. 2. Those which are very high in aluminum, have more iron than those in group 1, while the amount of quartz is the same. The laterites in this group are called bauxites. 3. Laterites whose alumina content ranges from 54.8 to 26.3 and whose iron oxide content ranges from 17.75 to 56.00% but whose quartz content is the same as that of groups 1 and 2. These are called "laterites *in situ* which are bauxites." 4.

TABLE III

COMPOSITION OF INDIAN LATERITES[2]

Constituents	Group 1 per cent	Group 2, per cent		Group 3, per cent			Group 4, per cent		
H_2O	33.74	26.47	26.94	26.82	14.39	13.31	11.42	7.73	10.74
Quartz	...	...	...	...	...	32.24	6.67	39.53	24.39
SiO_2	2.78	.93	2.35	3.90	.90	9.94	13.35	7.96	10.42
TiO_2	.04	1.04	6.61	.38	1.59	.04	0.25	.01	.01
CaO	.20	.36	0.15	.35	.64	.00	.00	...	.38
MgO	.03	...	...	...	.20	.00	.00	...	trace
Fe_2O_3	.44	4.09	6.53	13.75	56.01	8.77	41.50	28.38	47.39
Al_2O_3	62.80	67.88	57.50	54.80	26.27	35.70	26.81	16.39	6.67

Detrital laterites. In these the iron content is greater than that of aluminum and the amount of quartz ranges from 6.67 to 39.53%. In Table III are given the composition of representatives from these groups. Combined silica is designated as SiO_2 while free quartz is given under that heading.

[1] J. B. Harrison, *loc. cit.*

[2] H. Warth and F. J. Warth, *loc. cit.*

These figures show the wide range in composition of laterites. The iron and aluminum bear to each other a somewhat reciprocal ratio; when one is high the other is likely to be low. The degree of hydration is usually greater in the highly aluminous laterites, and correspondingly low in the highly ferruginous.

Laterites from Madagascar

Baur[1] gives a number of analyses of laterites derived from different rocks in Madagascar. See Table IV.

TABLE IV

COMPOSITION OF LATERITES FROM MADAGASCAR DERIVED FROM THE VARIOUS KINDS OF ROCK

Constituents	Granite, per cent	Diabase, per cent	Amphibole, per cent	Sandstone, per cent
Insoluble	3.32	3.78	15.79	75.38
Soluble SiO_2	1.29	14.17	6.98	0.50
Al_2O_3	60.86	44.87	43.37	12.87
Fe_2O_3	1.00	17.33	13.04	2.34
CaO	...	0.18	0.03	...
MgO	...	0.13	trace	trace
H_2O	33.42	20.06	21.78	9.51

Relationship of Laterite and Bauxite

It was noted in discussing the meaning of laterite, that there was nothing in the various terms used to describe laterite which would exclude bauxite. Warth and Warth[2] are very definite on this point in that they class certain laterites as bauxites. Lemoine and Chautard[3] state that the practical result of laterization is the deposition of bauxite. La Croix,[4] does not regard bauxite as a mineral because it does not have a constant composition; in France it approaches $Al_2O_3.H_2O$; in Arkansas $Al_2O_3.3H_2O$. Bauxite is a rock composed of various aluminum hydrates, mixed with ferric hydrate, clay and other impurities. Fermor[5] in dividing the bauxites of India into high-level and low-level laterite classes the bauxites with the high-level laterites, but not all high-level laterites are bauxites.

Baur[1] has shown that the laterites of the Seychelle Islands consist principally of hydrargillite and in this respect there is no difference between laterite and the bauxites of Vogelsberg and other places. Both are products

[1] Max Baur, *loc. cit.*

[2] H. Warth and F. J. Warth, *loc. cit.*

[3] Paul Lemoine and Jean Chautard, "The Phenomena of Laterization," *Bull. Soc. Geol. France*, **4** [8], 55–8; *C. A.*, **3**, 298 (1909).

[4] L. L. Fermor, *loc. cit.*; A. La Croix, *loc. cit.*

[5] L. L. Fermor, *loc. cit.*

of changes in aluminous minerals. Fox[1] has made a special study of the bauxite resources of India, and he concludes that bauxites occur only in association with the oldest laterites. In the formation of bauxite the softer ferruginous matter has been broken up and washed away, leaving the hard boulders of aluminous matter behind. Mead[2] divides the bauxites of Arkansas into two classes: (1) bauxites, in place and (2) bauxites, transported and detrital. The first is a residual product of the surface weathering of syenite. It grades downward into kaolin which in turn grades into syenite. The second represents material which was carried from the original position by streams during tertiary times.

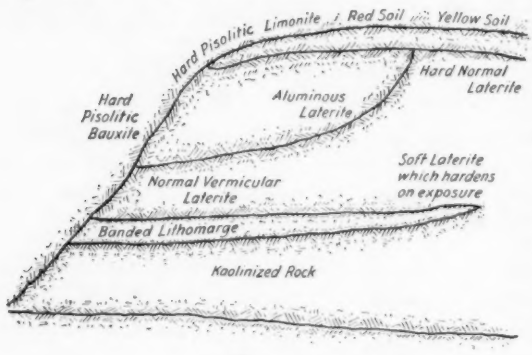

FIG. 1.

Bauxite has about 38% pore space and open texture is essential for its formation. In this respect the conditions for the formation of bauxite and laterite are similar. The alteration of clay to bauxite is accomplished through the agency of circulating solutions, which suggests that the stability of some clay is due to its imperviousness and that only open textured clay can be altered to bauxite.

Fox[1] gives a diagram which illustrates the relation between laterites and some bauxites. (See Fig. 1.)

The similarity in composition of bauxites and laterites is shown in the following tables:

TABLE V

CHEMICAL COMPOSITION OF UNALTERED SYENITE AND BAUXITE ORE OF ARKANSAS[1]

Constituents	Unaltered syenite, per cent	Bauxite ore, per cent
SiO_2	58.00	10.64
Al_2O_3	27.10	57.48
Fe_2O_3	1.86	2.56
FeO	3.30	.20
MgO	.25	...
CaO	1.62	...
Na_2O	6.70	...
K_2O	.25	...
TiO_2	.40	1.20
H_2O	1.20	28.36

[1] Cyril Fox, *loc. cit.*

[2] W. J. Mead, *loc. cit.*

TABLE VI

COMPOSITION OF BAUXITE OF ALABAMA AND ARKANSAS[1]

Constituents	Arkansas		Alabama	
	White, per cent	Red, per cent	White, per cent	Red, per cent
SiO_2	10.00	4.00	2.38	8.16
Al_2O_3	52.00	53.00	61.87	53.87
Fe_2O_3	4.00	10.00	.40	4.52
TiO_2	4.00	4.00	...	...
H_2O	30.00	29.00	30.50	24.86

TABLE VII

COMPOSITION OF BAUXITES FROM VARIOUS COUNTRIES[2]

Constituents	France		Hungary, per cent	Italy, per cent	United States, per cent	British Guiana, per cent
	A, per cent	B, per cent				
SiO_2	0.80	0.29	0.80	2.79	2.90	2.73
TiO_2	3.50	0.80	2.80	1.27	3.40	0.10
Al_2O_3	76.40	60.60	65.50	57.60	58.21	64.38
Fe_2O_3	4.80	26.00	21.30	28.55	3.60	0.50
CaO	...	...	...	...	...	...
MgO	...	...	...	...	...	...
H_2O	14.3	10.4	9.96	11.71	31.89	32.29

Summary

The term laterite means a red rock or red earth deposit. If bauxites are a species of laterite, then it may be said that scattered deposits of laterite are found in higher latitudes. The prevailing compounds in laterite are aluminum and iron hydroxides, found in somewhat reciprocal amounts. Silica is present mostly as free quartz in those laterites which have suffered transport since formation. Some laterites are very rich in aluminum hydroxide, others in iron hydroxide, still others are rich in free quartz and a variety of compounds; all are low in alkalies and alkaline earths. All red earths are not necessarily laterites.

Some laterites are classed as high-level laterites. These are formed *in situ* and are the purest. Others are classed as low-level laterites. These have usually suffered transportation since formation, and during this process have become mixed with various materials such as clay and quartz. Then there is laterized alluvium as well as variations between these classes. The upper surface of a laterite deposit often has a hard crust.

Laterites may be formed from a variety of rocks. Igneous rocks, particularly granites and gneisses, are the usual source. The process of laterization, and the modifications since formation have more to do with the character of the laterite formed than has the nature of the parent rock.

The hot, moist climate of the tropics, particularly the alteration of wet

[1] T. L. Watson, *loc. cit.*

[2] Cyril Fox, *loc. cit.*

and dry seasons, appear to be favoring conditions for the formation of laterite and necessary for the accumulation of extensive deposits. Laterite formation is probably as prevalent in the tropics as residual clay formation in the higher latitudes. One theory places microörganisms as the chief agents in laterite formation. One condition for the life of these organisms is a continuous warm climate.

The process of laterite formation, consists in the elimination of alkalies, alkaline earths, and silica from the original rock and the accumulation of the hydrated oxides. Physically it is necessary that the rock or earth undergoing laterization shall remain porous in order that the minerals in solution may pass from below upward, and also that there shall be surface drainage to carry away minerals in solution. Laterites are not formed where the water stands continuously. The destruction of capillaries by frost is given as one reason why laterites do not form in higher latitudes. In the formation of kaolin, two-thirds of the silica present in the feldspar is set free; in the formation of laterite, all the silica is set free.

Laterites may be so rich in aluminum hydroxide that they serve as an ore of aluminum. In such a case they are bauxites. They may also be so rich in iron hydroxide that they serve as iron ores. From this standpoint they are also of great economic importance.

NOTE:—The writer desires to express his appreciation to Dr. H. Ries of Cornell University for suggesting this study and for helpful assistance in preparing the manuscript.

Appreciation is also expressed to Professor T. L. Watson of the University of Virginia for reading the manuscript and giving constructive criticism.

METHOD FOR ANALYZING DIASPORE CLAY

By M. H. Thornberry

ABSTRACT

The method of analyzing refractories recommended by the A. S. T. M. having proved unsatisfactory for diaspore clays, a change has been made whereby fusion is accomplished by adding c. p. NaOH instead of Na_2CO_3 to the finely ground clay and the mixture heated in a nickel crucible over a bunsen burner.

The primary object of this article is an outline and discussion of the method used by the State Mining Experiment Station of the Missouri School of Mines and Metallurgy for the analysis of diaspore clay, but we feel that a few words of explanation relative to this special variety of clay will not be out of place before taking up the method for analysis.

Dana gives the following description of diaspore: fracture conchoidal, very brittle. Hardness 6.5–7. Gravity 3.3–3.5. Luster brilliant; pearly on cleavage face, elsewhere vitreous. Color whitish, grayish white, greenish gray, hair brown, yellowish to colorless. Composition AlO(OH) or $Al_2O_3.H_2O$. Alumina 85.0, water 15.0 = 100.

Diaspore clay at the present time is found in commercial quantities in Franklin, Casconade, Osage, and Phelps counties, Missouri. Prior to 1917 this clay was thrown aside as refuse. In January, 1917, W. S. Cox, Cuba, Mo., sent the writer a sample of this clay for analysis. As far as our knowledge goes Dr. Cox was the first operator to see the value of this material and should be given credit as the discoverer of diaspore clay in Missouri.

The writer has analyzed hundreds of samples of this variety of clay. A few complete analyses are listed below:

	Sample A	Sample B	Sample C	Sample D	Sample E
Silica (SiO_2)	11.04	3.88	10.24	7.64	15.96
Alumina (Al_2O_3)	70.72	76.07	70.04	68.11	62.38
Iron Oxide (Fe_2O_3)	1.57	3.03	2.29	6.05	3.41
Lime (CaO)	None	None	None	None	None
Magnesia (MgO)	None	None	None	None	None
Titanium (TiO_2)	3.11	4.14	4.19	4.13	3.87
Soda (Na_2O)	0.08	0.06	0.08	0.10	0.23
Potash (K_2O)	0.17	0.11	0.19	0.16	0.31
Ignition Loss	13.42	13.06	13.13	13.47	13.41
Total	100.11	100.35	100.16	99.66	99.57

The Missouri State Mining Experiment Station has been using for a number of years practically the same method for analyzing refractories as outlined in the *Proceedings of the American Society for Testing Materials.*[1] The carbonate fusion[2] was tried time after time for diaspore

[1] *Proc. A.S.T.M.*, 628–38 (1921).

[2] *Ibid.*, 630.

clays. The amount of flux, temperature, and time were varied but without success. In all cases a black, gritty, insoluble residue remained after treating the melt with acid. After repeated unsuccessful attempts to fuse the clay in this manner a method was worked out which has given complete satisfaction. The procedure of the method is practically identical with the one mentioned above, the only difference being the fusion.

Procedure of Method

Weigh 0.5 gram of the finely ground clay and transfer to a nickel crucible. (We find that a crucible $1^3/_4$ inches high and $1^5/_8$ inches in diameter is best suited for this work.) Add about $^3/_4$ inch of C. P. NaOH stick. (Care should be taken at this point because even some C. P. NaOH contains alumina.) Moisten with distilled water. Cover and heat gently over a blue flame of a bunsen burner until ebullition has ceased. Continue heating until the fusion is quiet and the lower half of the crucible is a dull red. Pour fusion on a nickel lid used for that purpose. Dissolve portion of fusion remaining in crucible and on its lid with hot water, transferring to a platinum dish or casserole, to which is added the melt from the other nickel lid. Add water until volume is about 100 cubic centimeters. Add about 20 cubic centimeters of concentrated HCl, keeping dish covered with a watch glass. Evaporate to dryness. The method from this point is practically identical with that as outlined in the bulletin mentioned, hence, no further discussion is necessary.

The advantage of this method is a complete fusion in a very short time. A sample can be weighed, fused, and prepared for evaporation in seven minutes.

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THE ANALYSIS OF REFRACTORIES

By C. A. Underwood

ABSTRACT

Methods for use in the analysis of refractories are described, including the preparation and solution of the sample and the determination of the content of silica, alumina precipitate, iron, titanium, alumina, lime, magnesia, and alkalies.

Introduction

The purpose of this paper is to set forth, in a general way, the methods used in the analysis of refractories. In this class of materials, as in others, there are precautions to be taken. Considerable time is required for the analyses, and the attempt to take short cuts often results in errors which would otherwise be avoided. It is also important to get the right start. Refractories are resistent to acids and often require strong fluxes to decompose them.

Preparation of the Sample

The method of taking a certain proportion of the whole, and quartering down applies to this class of work as it does to others. Very often it is simply a matter of judgment because no standard exists. However, it is well to remember in sampling bricks that only the inside portion should be taken. Silica brick, for instance, are sprinkled with sand during molding and setting, and the inclusion of the skin in the sample will affect the analysis.

The crushing is usually done in a small laboratory jaw crusher, but the pulverizer attachment is never used. There are cases where the iron content of dead-burned magnesite has been doubled by the use of the pulverizer. In its place a hardened steel mortar and pestle are used; the sample being pulverized to pass a 100-mesh screen by repeated crushings. It also might be mentioned that silica brick and ganister samples are treated with a magnet before proceeding with the analysis.

Solution of the Sample

Silica brick, ganister, magnesite and fire clays are all decomposed by fusion with sodium carbonate. After the melt has cooled it is treated with dilute hydrochloric acid and gently heated until all but the silica has gone into solution.

Diaspore, bauxite, spinel and chrome ore must be fused with potassium pyrosulphate. In the case of crude diaspore, it is desirable to drive off the combined water before making the fusion. Otherwise the substance floats on the fusion and is not attacked. A good way to proceed in this case is to determine the "loss on ignition" first and use a part of the ignited portion for the analysis.

Fine grinding in an agate mortar facilitates the decomposition of this class of materials. The pulp is usually ground until no gritty particles are felt when rubbed on the palm of the hand.

Silica

After the melt has been dissolved with hydrochloric acid the solution is transferred to an evaporating dish and evaporated to dryness on the water bath. When dry, the residue is baked at 120°C in a drying oven until all traces of acid have been expelled. It is then moistened again with dilute hydrochloric acid, evaporated and baked the second time. The residue is then dissolved in dilute hydrochloric acid and water and silica filtered off.

In the case of diaspore, bauxite, and spinel, dryness cannot be accomplished on the water bath alone. To attain this condition the evaporating dish is supported about two inches above the hot plate, placing sufficient asbestos padding beneath the dish to prevent heating too rapidly. It is not necessary to repeat the baking in this case.

The silica is purified with hydrofluoric acid on clays, diaspore, bauxite, spinel and chrome. The residue which is composed principally of iron, alumina and titania is fused with potassium pyrosulphate and added to the filtrate. On magnesite, silica brick and ganister the impure silica is reported. It has slight amounts of the impurities mixed with it but this is compensated by the small amounts of silica passing into the filtrate and which will be precipitated with the iron and alumina. This practice appears to be crude on first thought but it has been demonstrated in the course of many analyses that one error very nearly compensates the other. In fact, so much so that for commercial analyses, the practice has become general.

Some methods advanced for the analysis of magnesite, call for direct decomposition with hydrochloric acid. After the ore has been decomposed, the solution is evaporated to dryness and baked. The impure silica is purified with hydrofluoric acid and this result reported. It might be mentioned that on dead-burned magnesite, fairly uniform results are obtained by this method. The silica, however, will be 0.70% lower than the actual amount of silica present. By comparing the silica obtained by the sodium carbonate method with that obtained by an ultimate analysis, it can be shown that the silica content will be less than 0.30% low. Furthermore, the direct acid treatment cannot be successfully employed on crude magnesite.

Alumina Precipitate

By the addition of ammonia, alumina is precipitated together with iron, titanium, chromium, manganese, zirconium and phosphorous oxides.

The latter three constituents are rarely ever determined in commercial work. For magnesite, silica brick and ganister only one precipitation is made. Two precipitations are sometimes recommended for magnesite but if the solution is not too concentrated and if the ammonia is added a little at a time, good results can be obtained. Only a slight excess of ammonia should be used and the washing done with dilute ammonium nitrate solution.

Where potassium pyrosulphate is used to decompose a sample, weighable amounts of platinum are dissolved from the crucible. It is necessary to remove this by passing hydrogen sulphide through the solution. The platinum sulphide is filtered off and the iron reoxidized with bromine water before proceeding with the alumina precipitation. This procedure consumes considerable time and can be avoided in general work by weighing the crucible before and after the fusion. The loss in weight is then deducted from the weight of the alumina precipitate.

For chrome, diaspore, clay, etc., two precipitations in dilute solutions are necessary. The heavy precipitates in this class of substances adsorb large amounts of alkalies, which can only be removed by a second precipitation and thorough washing. It is a good plan to transfer the precipitates to the filter and wash five times, breaking up the precipitates with the stream from the wash bottle.

Either rosalic acid or methyl red is used as an indicator and great care should be exercised in following the color change. Hot dilute ammonium nitrate or chloride should be used for the washings, otherwise small amounts of the alumina will pass into the filtrate.

Iron

Iron is usually reported as Fe_2O_3 except in the case of chrome ore where it occurs principally as FeO. Chrome ore contains both oxides as a rule but in technical work the determination of the ferrous oxide is seldom made.

In diaspore, clay, etc., where titanium is present in appreciable amounts, hydrogen sulphide is employed as the reducing agent. In silica brick, ganister, magnesite and chrome, titanium is usually present in very small amounts and in these substances the iron may be reduced with zinc. This distinction is made because zinc reduces the titanium as well as the iron, thus giving high results. $N/25$ potassium permanganate is used in the titration; a 500 cubic centimeter Erlenmeyer flask being employed for both the reduction and the titration.

Titanium

Titanium is determined by the colorimetric method, the solution used for the titration of iron being best adopted for this purpose. There are

many precautions to be taken. The procedure is described in detail in the text books so that it is unnecessary to go into it here.

Alumina

The percentage of alumina is obtained by deducting the iron and titanium from the total "alumina precipitate."

Lime

The determination of lime in silica brick, ganister and clays offers no difficulty. After precipitating with ammonium oxalate and ammonia the solution is allowed to evaporate to 150 cubic centimeters. During this time the calcium oxalate will settle completely. It is then filtered and titrated with $N/25$ potassium permanganate.

In diaspore, spinel, and chrome the precipitation is carried out in the same way except that it is allowed to stand over night. It has been found that where large amounts of alkali sulphates are present, the calcium oxalate does not precipitate as readily as when they are absent. Hence, the longer time allowed for complete precipitation. The next morning the calcium oxalate is filtered off, redissolved with dilute hydrochloric acid, and precipitated the second time. It will now settle quickly and be entirely free from magnesium salts.

The determination of lime in magnesite is subject to a considerable error owing to the large amount of magnesium present. Various methods have been proposed but sufficient work has not been done to settle this question. A method which has found considerable use is given here.

To the cold filtrate from the iron and alumina precipitation, add 10 grams of ammonium chloride (if it has not already been added before the iron and alumina precipitation), 40 cubic centimeters of concentrated ammonium oxalate and 1 or 2 cubic centimeters of ammonia. Stir and allow to stand over night. Filter off the precipitate and wash not more than once or twice. Redissolve into the original beaker, add 10 grams of ammonium chloride, a few cubic centimeters of ammonium oxalate and a few drops of methyl orange. Heat to boiling and precipitate with ammonia. Bring just to boil and allow to settle hot for one and one-half hours. Filter and wash slightly as before. Redissolve in hydrochloric acid and make a second hot precipitation. Allow to stand as before and filter. Wash six times with hot water and titrate with potassium permanganate. The procedure in general is one cold and two hot precipitations. The volumes should be from 400 to 500 cubic centimeters.

Magnesia

The determination of magnesia is discussed thoroughly in the text-books and nothing need be added here. It might be mentioned that two pre-

cipitations are desirable, especially where the magnesia is high and large amounts of fixed alkalies are present. In the technical analysis of magnesite and dolomite, the magnesia is usually determined by difference. This procedure saves much time and is sufficiently accurate for most purposes.

Alkalies

Potash and soda are determined by the J. Lawrence Smith method.

Conclusions

The correct summation of analyses is an important consideration and affords a good indication of the quality of the work.

In commercial analyses, chrome ore might be said to be an exception. Only the total oxides of iron are determined, as a rule, and reported as FeO. However, there may be several per cent of the iron present as Fe_2O_3 and unless both oxides are determined separately there is no way of knowing how to report the analysis. Again the "ignition loss" gives low results as compared to the actual determinations of combined water. This discrepancy may be considerable since there is a tendency for the ferrous oxide to be oxidized to ferric oxide. Hillebrand states: "Loss on ignition with carbonate rocks represents, as with those of a silicate nature, the algebraic sum of a number of chemical changes involving both losses and gains, and its amount will depend largely on the temperature employed."

Clays offer no difficulty in obtaining a summation of 100 to 100.50%.

Diaspores can be made to total under 100.50% but all the refinements must be exercised.

Magnesite is difficult to bring within reasonable limits when the MgO content is actually determined, especially is this the case with calcined magnesite. An aliquot part must be taken and a second precipitation made to eliminate the alkalies present. A small plus error will be multiplied many times in calculating the per cent.

Silica brick and ganister will total between 100 and 100.20%. Usually only the silica, iron, alumina and lime are determined and in this case, the summation ranges from 99.60 to 99.85%.

References

William Blum, "The Determination of Alumina as Oxide," Bur. Standards, *Sci. Paper* **286.**

W. F. Hillebrand, "The Analysis of Silicate and Carbonate Rocks," U. S. Geol. Surv., *Bull.* **422** (1916).

J. W. Mellor, "A Treatise on Quantitative Inorganic Analysis," London, 1913.

H. S. Washington, "The Chemical Analysis of Rocks," New York, 1919.

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MEASUREMENT OF THE HEAT ABSORBED AND EVOLVED BY CLAYS DURING FIRING AND COOLING[1]

By Louis Navias

ABSTRACT

Apparatus.—A vacuum calorimeter containing an insulated platinum resistance furnace is described for use in determining reaction heats, and the heat absorbed in raising the temperature of a material in the furnace from room temperature to 1200°C, and also the heat evolved in cooling down the material from 1200°.

Materials experimented with.—Four typical clays are employed, namely A-1 English china clay, North Carolina kaolin, Tennessee ball clay No. 5, and Laclede-Christy raw flint clay. The calorimeter is calibrated with pure quartz.

Results.—The numerical data obtained are assembled in Table IV. The quantity of heat absorbed per gram per degree on heating the air dried clays over the complete temperature range 25–1200° amounts to 0.50–0.55 calories, whereas the heat evolved on cooling the final products per gram per degree through the range 1200–700° is 0.23–0.29 calories.

The heat absorbed in the ranges 24–420°, 420–900°, and 900–1200°, together with the heat evolved in the ranges 1200–900°, and 900–700°, are also given for all of the above clays.

I. Introduction

1. Purpose of the Investigation.—When refractory materials are fired, heat is absorbed, the net quantity depending upon the specific heats and upon the heats of reaction resulting from chemical and physical changes in the constitution of the fired material. Exothermic reactions help to raise the temperature of the materials whereas endothermic reactions require an additional amount of heat to complete them, before the temperature can again rise. In materials like clays, and in bodies containing them, these reactions are quite often not reversible, meaning that the heat absorption on firing is not equivalent to the heat evolution on cooling. It is impossible then, with such materials to obtain the heat absorption on firing by the method of mixtures, which is the usual method employed for determining specific heats.

In the method of mixtures, the substance is heated to a high temperature, and the resulting heated material is dropped into a calorimeter, and the heat evolved by the material measured by the increase in temperature of the calorimeter bath. The present investigation has primarily for its purpose the measurement of the heat energy required to raise the temperature of raw clays, from room temperature to 1200°C, by a method and apparatus devised for the work. An experiment is run continuously on one sample to the highest temperature, and the heat absorption is measured

[1] This paper is an abstract of a thesis presented to the graduate school of the University of Illinois in partial fulfilment of the requirements for the degree of Doctor of Philosophy in Ceramic Chemistry, in February, 1923.

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for three separate ranges of temperature; then the energy source is cut off, and the heat evolved by the fired material as it cools to 700° is measured over two ranges of temperature.

All temperatures given in this paper are in degrees centigrade.

2. Data in Literature on Specific Heats of Minerals, Refractories and Clays.—These are all data on materials experimented with by the method of mixtures.

(*a*) *Minerals.* White[1] obtained the Interval Mean Specific Heats on the silica minerals, quartz and cristobalite, on the feldspars, anorthite, andesine, albite, microcline, and on other natural minerals as pseudo-wollastonite, and on some of the natural forms of magnesium silicate. White also worked with some of the glasses of the above materials. His range of temperature was from room temperature to 1400°. From the data, he calculated the true instantaneous specific heats at different temperatures. His data will be referred to later.

Wietzel[2] found the Interval Mean Specific Heats of cristobalite, quartz, chalcedony and silica glass up to 1400°. The data on quartz and cristobalite are discussed in a later chapter.

(*b*) *Refractories.* Bradshaw and Emery[3] have obtained the Interval Mean Specific Heats on some refractory materials up to 1400°. Table I gives their results in calories per gram from $t°$ to 25°.

TABLE I

INTERVAL MEAN SPECIFIC HEATS OF REFRACTORY MATERIALS $t°$ TO 25°

$t°$	Silica brick	Fire brick	Pure zirconia	Stourbridge fire brick
600	0.226–8	0.228	0.137	0.227
1000	.263–2	.265	.157	.263
1200	.282–3	.284	.167	.262
1400	.293–5	.297	.175	...

Tadokoro[4] experimented with different types of brick to 900°. The Interval Mean Specific Heats in calories per gram from $t°$ to 30° are given in Table II.

Moore[5] worked with a terra cotta body that had been burned to 1100°. In cooling from $t°$ to 0°, when $t°$ is equivalent to 500°, 700° and 900°, the Interval Mean Specific Heats in calories per gram are 0.235, 0.245 and 0.249, respectively.

[1] W. P. White, *Amer. Jour. Sci.*, **47**, 1–43 (1919).

[2] Rudolf Wietzel, *Z. anorg. allgem. Chemie*, **116**, 80 (1921).

[3] L. Bradshaw and W. Emery, *Trans. Ceram. Soc.* (Eng.), **19**, 84–92 (1919–20).

[4] Yoshiaki Tadokoro, *Sci. Repts.* (Tôhoku Imp. Univ.), **10**, 339–410 (1921).

[5] J. K. Moore, "Tests on the Thermal Conductivity of Terra Cotta Fireproofing," Thesis for B.S. Univ. Ill. (1908).

TABLE II

INTERVAL MEAN SPECIFIC HEATS OF BRICK, $t°$ TO 30°

$t°$	Magnesia	Red clay	Silica	Chrome	Shamotte
218	0.223	0.207	0.199	0.178	0.197
303	.238	.221	.218	.195	.209
382	.254	.239	.233	.210	.222
480	.263	.247	.246	.216	.238
579	.266	.249	.249	.221	.251
687	.265	.247	.250	.219	.255
796	.264	.242	.247	.218	.249
894	.263	.237	.242	.215	.241

(*c*) *Clays.* Knote[1] determined the specific heat of a flint clay from Olive Hill, Kentucky, from 150° to 22°. The raw clay had a specific heat of 0.237, the clay burned to 650°, a specific heat of 0.204, and when burned to 1050°, a specific heat of 0.200.

3. Method, General Description.—The method employed consisted of immersing in a thermostat at room temperature a small vacuum jacketed furnace containing the sample of material to be investigated. The furnace was heated electrically by means of a platinum heating coil and the energy supplied in this way was accurately measured by means of a recording wattmeter. A thermocouple was inserted in the center of the charge for reading its temperature. The whole furnace was encased in a nickel cylinder which was evacuated, the whole being immersed in the water of the stirred bath.

During the passage of the heating current, some of the energy supplied to the furnace leaked out through the nickel containing cylinder into the water of the bath. This tended to raise its temperature above that of the room. In order to prevent this and to measure the energy which leaked out in this way, ice water was admitted to the bath at such a rate as to keep its temperature practically constant. An equivalent amount of water from the bath overflowed and was collected in a container for weighing. When, with a given heating current, the temperature of the center of the charge became constant and remained so for some time, this temperature was read and the container which received the overflowing water was removed and replaced by a second container. The heating current was then immediately raised to the second level and the above procedure repeated, as soon as the temperature of the center of the charge had again become constant at the higher value.

By weighing the water which overflowed from the water bath, the amount of energy which leaked out of the furnace through each stage could be accurately computed. From the record of the wattmeter, the amount of energy sent into the furnace could be similarly accurately

[1] J. M. Knote, *Trans. Amer. Ceram. Soc.*, **14**, 394–8 (1912).

computed. The difference between these two amounts obviously represents the heat absorbed by the charge and the furnace parts. The heat was measured with an accuracy of about 1% in the present investigation.

In order to determine the amount of heat absorbed by the furnace parts during the operation, the same series of experiments was repeated, using in place of the charge of clay a charge consisting of a known weight of quartz whose specific heat curve up to high temperatures has been accurately determined. In this second series of experiments, the heat absorbed by the charge is known and by subtracting this from the total heat absorbed by the furnace plus the charge, the heat taken up by the furnace parts could be computed. By combining this value with the results obtained when using the various clays in the furnace, the heats absorbed by the clays themselves can obviously be calculated. It is estimated that this heat was measured with an accuracy of about 10%.

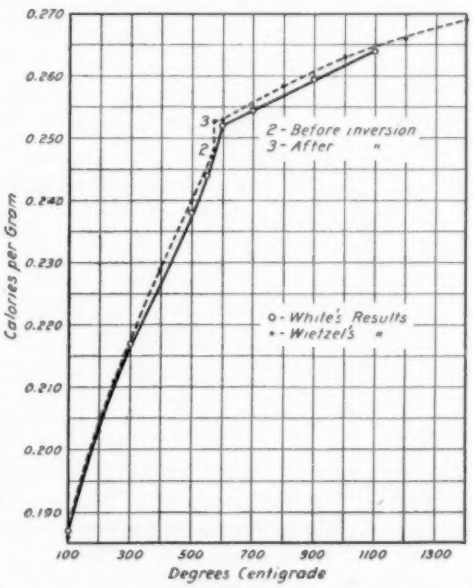

FIG. 1.—Average specific heats between 0° and t° of quartz.

It was found expedient to limit the temperature ranges to approximately 24–420°, 420–900°, 900–1200° for ascending temperatures, and 1200–900°, 900–700° for descending temperatures.

4. Available Specific Heat Data for Calibrating the Calorimeter.—The only data that are given on pure materials and over the complete range of temperatures from 0° to 1400° are those furnished by the experiments of White[1] and Wietzel.[2] The list of materials contains feldspars and magnesium silicates, which however are difficult to obtain with theoretical compositions. The glasses of these minerals crystallize fairly easily, which decreases their value for calibration purposes. The only other materials that can be considered are, then, quartz and cristobalite, data being furnished by both experimenters. Figures 1 and 2 give the complete data.

It will be noticed that the data on the quartz are much more concordant than are the data on the cristobalite. Wietzel has shown, as have others,

[1] W. P. White, *loc. cit.*

[2] Rudolf Wietzel, *loc. cit.*

as Washburn and Navias,[1] that the physical properties of cristobalite depend on the previous history of the material, that is, of preparation and of the extent of calcination.

For quartz, White gives values only up to 1100°, whereas Wietzel gives them as high as 1400°. In a preliminary run of the present investigation, crushed quartz heated to 1400°, in eight hours, gave inversion to cristobalite of about one quarter of the material. In two regular runs, quartz heated to 1200°, in ten hours each, gave no trace of inversion. This was determined by measuring the index of refraction of the grains. As the maximum temperature to be attained safely in the calorimeter is 1200°, quartz may be used to advantage. By adding Wietzel's result at 1200° to those of White's at lower temperatures, the data are complete for application to the present problem. As the work of White has extended over many years and with concordant results, preference has been given to his work.

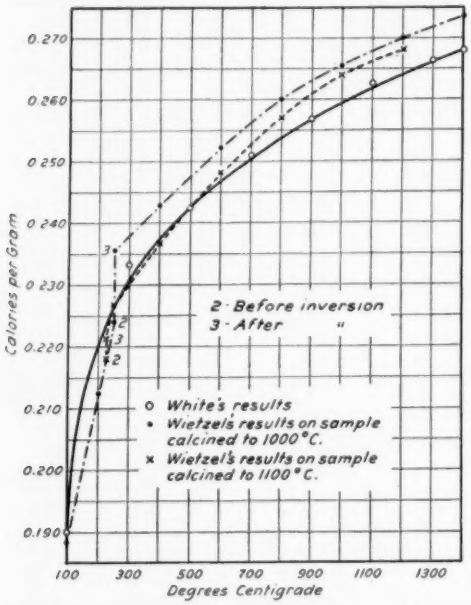

FIG. 2.—Average specific heats between 0° and t° of cristobalite.

II. Heats of Reaction of Clays at High Temperatures

5. Clays Experimented with.—The clays experimented with are typical of the different kinds used in the industries. Unfortunately the choice had to be limited to the purest clays, on account of the conditions under which the experiments were made. Attempts to experiment with brick clays and the like, have resulted in wrecking of the furnace, due to the bloating of the clays. The chemical analyses of the clays are given in Table III.

6. Reactions in Clays Due to Heating.—Mellor and Holdcroft,[2] working with kaolinite, determined from their time-temperature curves ob-

[1] Edward W. Washburn and Louis Navias, *Jour. Amer. Ceram. Soc.*, **5**, 565–85 (1922).

[2] J. W. Mellor and A. D. Holdcroft, *Trans. Ceram. Soc.* (Eng.), **10**, 94–120 (1910–11).

TABLE III

CHEMICAL ANALYSES OF THE CLAYS EXPERIMENTED WITH

	(1) Per cent	(2) Per cent	(3) Per cent	(4) Per cent
SiO_2	45.20	45.2	45.60	43.70
Al_2O_3	38.45	38.8	35.90	39.38
Fe_2O_3	0.45	0.3	1.00	0.79
TiO_2	trace	trace	1.00	1.95
CaO	trace	0.9	0.10	0.10
MgO	trace	.8	.30	.37
Na_2O	0.00	2.1	.46	trace
K_2O	.65		.72	
H_2O	14.80	...	...	....
Ign. loss	...	12.5	14.60	14.08
	99.55	100.6	99.68	100.37

(1) North Carolina kaolin (Harris Clay Co., Sprucepine).
(2) A-1 English china clay (Hammill and Gillespie).
(3) Tennessee ball clay No. 5 (Mandle Clay Mining Co.).
(4) Laclede-Christy raw flint clay (Missouri).

tained by a differential thermal method and from other experiments the following results:

(1) Just above 500°, heat is absorbed by an endothermic decomposition of kaolinite into free silica, free alumina and water. Graphically the "latent heat of decomposition" is calculated to be 42 calories per gram of raw clay.

(2) At approximately 800°, in the heating curve, there is an exothermic change shown corresponding with a physical change of the free alumina, whereby the alumina becomes less soluble in acids, less hygroscopic and more dense. The "latent heat of transformation" is determined graphically to have the value of 21.5 calories per gram.

(3) The formation of sillimanite in kaolinite when heated over 1200° is due to the recombination of the free alumina with some free silica formed at about 500°.

Wallach,[1] by a differential thermal method, has shown that kaolin, clays, mica and glauconite absorb heat when dehydrated between 450° and 600°, and evolve heat between 900° and 1000°. According to Le Chatelier the evolution of heat is due to a transformation of the alumina. Wohlin[2] substantiates the above results by a similar method. In clays, between 560° and 580°, there is an endothermic reaction, at 960° the reaction is exothermic. Bauxite, $Al_2O_3.H_2O$, has an endothermic reaction at 540°, while bauxite $Al_2O_3.3H_2O$ has an endothermic reaction at 310°—both having exothermic reactions at 1060°.

Zoellner[3] heated clays to high temperatures and then disintegrated the products in hydrofluoric acid. The residue consisted of sillimanite crystals. He determined that cone 10 (ca. 1300°) had to be reached before

[1] Ruby Wallach, *Compt. rend.*, **157**, 48–50 (1913).
[2] R. Wohlin, *Sprech.*, **46**, 719–21, 733–5, 749–51, 767–9, 780–2 (1913).
[3] Zoellner, *Brit. Clayworker*, **22**, 40 (1913).

sillimanite could be obtained, and also that the plastic clays gave only 3–5% sillimanite, whereas the lean clays (kaolins) gave 25% under similar conditions of firing.

In Fig. 3 is shown the results of a thermal analysis of North Carolina kaolin, determined from the time-temperature readings taken on heating a sample of the clay in a resistance furnace. It shows that most of the water of combination is disengaged between 535° and 600°.

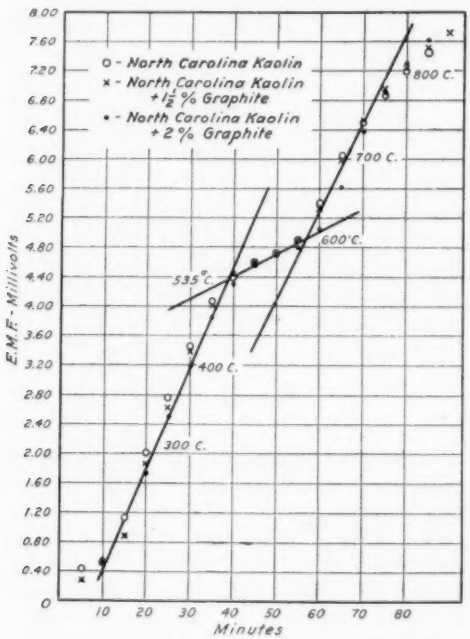

FIG. 3.—Thermal analysis of North Carolina kaolin.

Satoh[1] has determined qualitatively, by a very sensitive differential method, using quartz sand as a comparison substance, the heat reactions occurring in a Japanese kaolinite. His results may be summarized as follows

(1) Heat absorption up to 100°, due to evaporation of moisture contained in the specimen.

(2) Weak heat evolution from 100° to 300°, possibly due to oxidation of foreign minerals and organic substances.

(3) Heat absorption from 450° to 650°, due to the dehydration of the kaolinite.

(4) Heat absorption from 650° to 700°, due to the dissociation of kaolinite into free alumina and free silica.

(5) Weak heat evolution near 950°, due to the polymerization of the alumina.

(6) Weak heat evolution between 1200° and 1300°, due to the formation of amorphous sillimanite by the recombination of dissociated free alumina and free silica.

7. Evacuation of Raw Clays.—In preliminary runs the platinum container was filled with the powdered clay, and then evacuated in the system. Under these conditions, even with perfect control of the rate of evacuation, it was uncertain whether the clay had remained in the container, or had been partly expelled by the sudden expansion of gases. It was then found necessary to mold and press the clay, as described elsewhere, in order to keep the clay in the container. This procedure has a number of recommendations apart from the above-mentioned one. It approaches the methods used in practice, and also allows a larger sample to be employed—roughly from 200 to 300 grams.

[1] S. Satoh, *Jour. Amer. Ceram. Soc.*, **4**, 182–94 (1921).

8. Pressures Developed by the Dissociation of Clays.—Throughout the experiments, the vacuum pump is kept running, and with unhydrated materials, the pressure is kept down to a fraction of a mm. of mercury throughout the run. With clays, as the temperature varies, and with continuous withdrawal of the water vapor by the pump, a pressure is developed in the calorimeter depending upon the quantities of water vapor being expelled. These are not equilibrium vapor pressures, but they show relatively the velocities with which the dissociation of the clay takes place, as the temperature rises. Figures 4, 5, 6 and 7 show the changes in pressure with temperature for the clays investigated.

In the range 0–400°, the increase in pressure between 30° and 100°, shows that the clays are giving off adsorbed moisture held so tenaciously

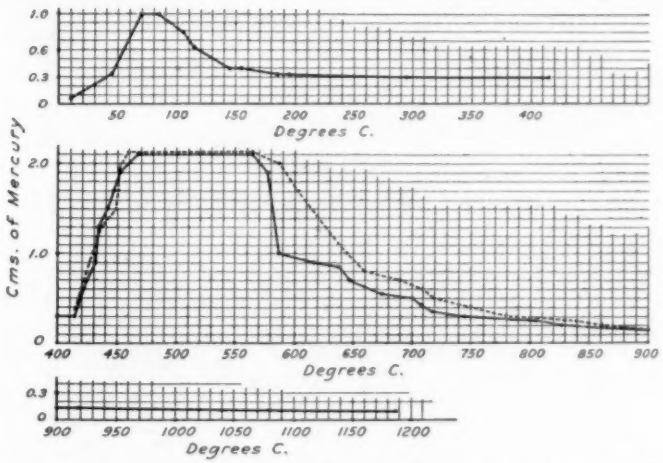

FIG. 4.—Pressure developed by the dissociation of North Carolina kaolin.

as not to be given off by the clays on drying at 110° at atmospheric pressure, or by continued evacuation at room temperatures.

In the range 400–900°, the dehydration of the clays seems to take place in two stages. In the first stage, the evolution of water vapor starts rapidly at about 475°, developing a pressure of about 2.2 centimeters. This maximum is maintained while the temperature rises 100–200°, depending upon the clay. Then appears the second stage, in which the dehydration velocity is suddenly lessened, but falls in a rather decisive and continuous manner, while the temperature rises 200–300° depending upon the clay.

In the range 900–1200°, only those clays containing organic matter developed pressures. The Laclede-Christy raw flint clay showed only a slight increase in pressure, but the Tennessee ball clay No. 5 developed

a rather high pressure. The run on the latter clay through the ranges 400–900°, and 900–1200°, was characterized by extremely bad odors issuing from the vacuum pump, due to the decomposition of the organic matter

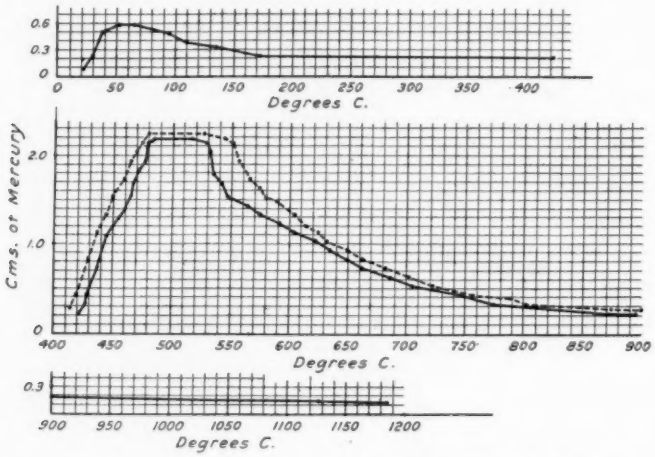

FIG. 5.—Pressure developed by the dissociation of A-I English china clay.

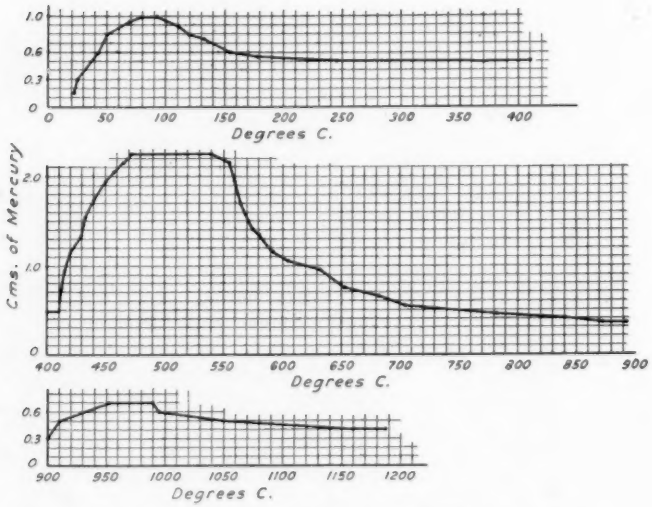

FIG. 6.—Pressure developed by the dissociation of Tennessee ball clay No. 5.

present. After cooling, the clay was found to be colored black throughout.

9. The Heat Effect of Carbon and Sulphur in Clays.—The combustion of one gram of carbon to carbon dioxide liberates 8080 calories of heat.

The combustion of one gram of sulphur to sulphur dioxide liberates 2240 calories. If the clay contains an appreciable amount of these constituents, especially of the former, the heat effect is theoretically large.

From the "Paving Brick Clays of Illinois,"[1] the following are the carbon and sulphur contents of some usable clays:—

	K_1	K_3	K_4	K_5	K_7	K_{14}	K_{15}	F_1	Average
S in %	0.27	0.16	0.14	0.11	0.13	0.24	0.25	0.32	0.18
C in %	1.44	1.50	.72	1.26	.71	1.01	.90	.92	1.05

Assuming these averages for a clay, the heat given up by the complete combustion of the carbon and sulphur in 100 grams of clay would be:

For C	$1.05 \times 8080 =$	8484 calories
For S	$0.18 \times 2240 =$	403 calories
		8887 calories

Assuming the specific heat of clay to be 0.70 in the range of combustion, 400–900°, then if heat was evolved at one time, and if all of the heat went to raising the temperature of the clay, the sudden rise of temperature would be about 125°. In practice, since the oxidation period extends over a long length of time, and over a wide range of temperature, such sudden increases in temperature are not to be expected. The heat evolved, however, is taken up by the material and its surroundings.

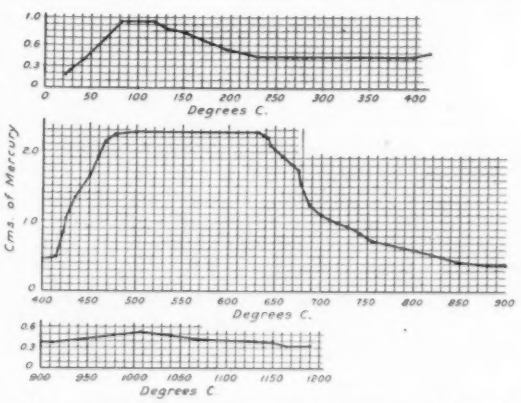

FIG. 7.—Pressure developed by the dissociation of Laclede-Christy raw-flint clay.

While obtaining the thermal analysis of the North Carolina kaolin an attempt was made to obtain a heat effect with the addition of 1.5% graphite, and in another case with 2% coal. The attempts were unsuccessful because these materials burned only partially, and also because the heat generated went to heating the furnace as well as the clay.

In the vacuum furnace there is no opportunity for the carbon and sulphur to oxidize and burn, hence these heat effects are lost. It is for this reason also that pure clays were selected.

[1] Ill. State Geol. Surv., *Bull.* 9, 284–5 (1908).

III. Description of Apparatus

10. General Set Up.—The following is a detailed description with dimensions of the apparatus. Fig. 8 is a photograph of the apparatus ready for a run. The letters correspond with those in the figures.

(*a*) *Ice Water Tank.* A wooden barrel 32 inches deep and 20 inches in diameter, heavily lagged on bottom and sides with felt.

(*b*) *Tube Stirrer.* A rotating metal spiral in a copper cylinder 36 inches long and 5 inches in diameter.

(*c*) *Needle Valve.* A $^1/_4$-inch brass globe valve, set between the ice

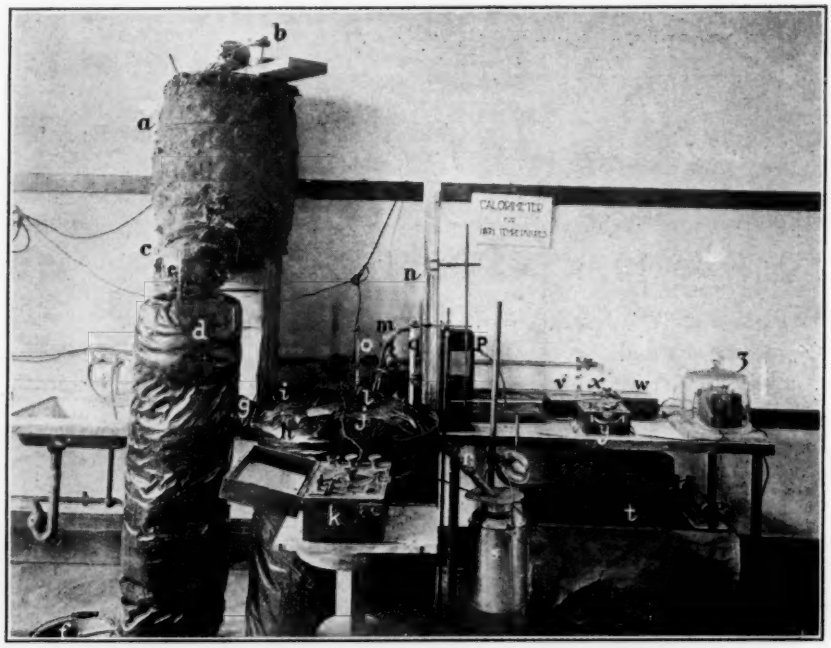

FIG. 8.—General view of apparatus.

water tank and the tube water cooler. With the valve wide open and ice water passing through the coils, the capacity is about 1000 cubic centimeters per minute.

(*d*) *Tube Water Cooler.* A galvanized iron cylinder, 48 inches high, 10 inches in diameter, containing the copper coils, with false perforated bottom, and with 1-inch outlet at bottom.

Copper Coils. Two coils, about 50 feet each, and $^3/_8$-inch and $^1/_2$-inch in diameter, respectively. They are coiled in a close spiral 6 inches in diameter and for a depth of 30 inches. They are con-

nected at the inflow end with a copper box into which the ice water flows from the ice water tank. At the outflow end there is an overflow box, made of copper, 3 inches deep and 3 inches in diameter, with the water level at $1^1/_2$ inches. The top of overflow box is 10 inches below the top of the galvanized cylinder, and the box has a copper tube extending out of it, to hold the long range zero-degree thermometer.

(*e*) *Thermometer, 0°, Long Range.* Mercury bulb, $1^1/_4$ inches long, mercury thread 16 inches long to 0° mark. Graduated in $^1/_{10}$° divisions from 0° to 10°. Stem $^1/_4$-inch in diameter. Immersed in water in box to depth of $1^1/_2$ inches. It was compared with a standard in ice water, and found to be exact at 0°.

(*f*) *Drainage Outlet.* The outlet for drippings from the ice water in the tube water cooler.

(*g*) *Vacuum Tube.* A tube 12 inches long and $^1/_2$-inch inside diameter was sealed at the ends onto a tube of $^3/_4$-inch inside diameter, leaving an air space between them. This space was evacuated to .002 millimeters pressure of mercury, and sealed off. The tube connects the overflow box, through the wall of the galvanized cylinder, to the calorimeter bath, through a hole in its side. The tube is heavily lagged with felt and covered with oilcloth.

(*h*) *Calorimeter Bath.* An enameled iron bath, 33 inches high and 22 inches in diameter. It is $29^1/_2$ inches deep from the overflow. With the calorimeter in place, the bath will hold 400 pounds of water, at 17°. It is lagged with 2-inch felt on sides and bottom, and stands on a wooden platform 5 inches above the floor. The felt is covered with oilcloth to prevent it from getting wet.

Bath Cover. This is a galvanized iron cover that fits tightly, and is covered with a 2-inch layer of felt. Soldered metal tubes in the cover allow for the extension of the stirrer shaft, Beckmann thermometer, electric current leads and vacuum connection.

(*i*) *Tube-Stirrer.* A rotating metal spiral in a copper cylinder 28 inches long and 3 inches in diameter. The stirrer is fastened to the side of the bath, and rotates so as to draw the water downwards in the tube.

(*j*) *Electric Current Leads.* Three pairs of wires emerge from a central tube in the cover. (1) Heavy wires for the current, (2) light wires for the potential leads, and (3) light wires for the thermocouple leads.

(*k*) *Potentiometer.* A Leeds and Northrup instrument with millivolt scale graduated in $^1/_{10}$ millivolts. The one hundredths can easily be estimated. The two graphs seen next to the instrument are (1) the e. m. f. temperature conversion chart, and (2) the deviation curve for the thermocouple.

(*l*) *Vacuum Connection.* A rubber hose connection from the calorimeter in the bath, through a tube in the cover, and connected on the outside of the bath to a glass double *L*. The double *L* then connects to (1) Vacuum pump, (2) mercury *U*-manometer and (3) stopcock leading directly to the atmosphere.

(*m*) *Vacuum Pump.* A Hyvac pump made by the Central Scientific Company. The pump is kept running continuously throughout an experiment.

(*n*) *Mercury U-Manometer.* The long arm was evacuated and sealed off. When attached to the evacuated apparatus, the mercury in both arms is at the same level.

(*o*) *Stopcock and Pinchcock.* A well ground stopcock with a pinchcock on a heavy rubber hose, to control the pressure in the vacuum furnace when necessary.

(*p*) *McLeod Gauge.* Capable of reading to one thousandth of a millimeter of mercury. The gauge is connected to the vacuum pump through one arm of a *T*, the other arm being connected to the double *L*.

(*q*) *Beckmann Thermometer.* Graduated in one hundredths of a degree. The bulb $1^1/_8$ inches long and $^1/_2$-inch in diameter rests in the water in the bath, a few inches away from the overflow.

(*r*) *Overflow* (*Bath*). As ice water is put into the bath through (*g*), the overflow of the bath escapes through (*r*).

(*s*) *Tared Container.* Cans with close fitting covers are used to collect the bath overflow.

(*t*) *Rheostats.* Two plate rheostats in series. A slide wire rheostat in parallel with one plate rheostat for fine adjustment.

(*u*) *Knife Switch.*

(*v*) *Ammeter.* 0–10 ampere range. Divisions, 0, 1, 2, from 2–10 in one-tenths.

(*w*) *Ammeter.* 0–50 ampere range. Divisions, 0, 5, 10, from 10–50 in $^1/_2$ units.

(*x*) *Knife Switch.*

(*y*) *Wattmeter.* General Electric Company. Scale 0–500 watts. Amperes 10 and 20, volts 75 and 150, maximum combinations.

(*z*) *Test Meter.* Portable Type IB-5, for alternating current circuits. Amperes 1 and 10. Volts 110. Cycles 60. Two coils, for 1 ampere fuse and for 10 ampere maximum through instrument. The instrument is a revolution counter with three dials.

Dial (1) reading total of 100 revolutions, divided in 10's.

Dial (2) reading total of 10 revolutions, divided in units.

Dial (3) reading total of 1 revolution, divided in $^1/_{100}$ revolution.

When using the 10 ampere coil on the 110 volt circuit, but irrespective of the voltage drop on it, the constant for the instrument

is 0.6 watthours per revolution. Maximum load, 10 amperes. General Electric Company product.

11. **Calorimeter Set Up.** (**Description of Figure 9.**)—(*a*) *Platinum Container.* Made of 0.004 inch sheet, $8^1/_4$ inches high, $1^3/_8$ inches in diameter, with the bottom end closed, weighing 51.0 grams.

(*b*) *Alundum Furnace Core.* 10 inches long, $1^1/_2$ inches bore, $^1/_8$-inch wall, closed at one end. It has a double thread for holding the resistance wire in place—$^1/_6$-inch apart.

(*c*) *Alundum Cylinder.* 10 inches long, $1^3/_4$ inches bore, and $^1/_8$-inch wall, open at both ends.

(*d*) *Porcelain Cylinder.* Made of a good refractory body, 11 inches high, 3 inch bore, and closed at one end.

(*e*) *Nickel Cylinder.* Made of sheet nickel, one millimeter thick, with a nickel sheet cap at the bottom. It is just large enough to hold the porcelain cylinder.

(*f*) *Porcelain Upper Support.* This is made to fit over the top of the nickel cylinder, $3^1/_4$ inches to $3^1/_2$ inches in diameter, ending in a hollow stem, $1^1/_8$ inches outside diameter and $1^1/_4$ inches high, which fits into the calorimeter cover.

(*g*) *Porcelain Lower Support.* This is made to hold up the nickel cylinder in a holder $3^1/_2$ inches in diameter, and 1 inch high, the holder terminating in a slightly tapered hollow stem 3 inches long and tapered from 1 inch to $^3/_4$-inch.

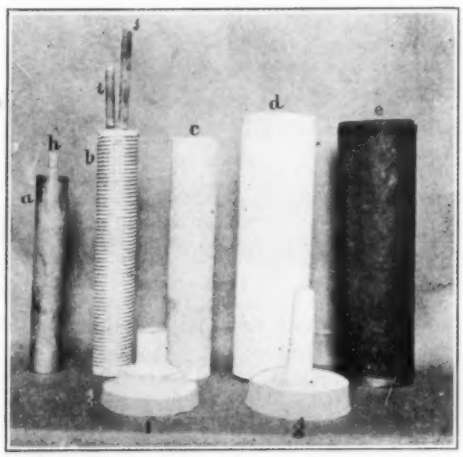

FIG. 9.—Platinum container and furnace parts.

(*h*) *Porcelain Insulator.* About 6 inches long, 6 millimeter bore and 2 millimeter wall, closed at one end. It is imbedded in the material held in the platinum container, so that the closed end is situated half way down the material and centrally located.

(*i*) *Porcelain Insulator.* 6 millimeter bore and 2 millimeter wall.

(*j*) *Platinum Resistance Wire.* 28 feet long, 0.036 inch in diameter and weighing 120.30 grams, wound non-inductively on the core (*b*). Above the core, the ends of the wire are trebled so as to form heavy leads for the current, and are encased in the porcelain insulators.

Description of Figure 10.—(*a*) *Metal Calorimeter.* Made of nickel-plated copper, $14^3/_4$ inches high, $7^3/_4$ inches inside diameter, and $^1/_8$-inch wall. It has a bottom screwed in and soldered air tight. In the center of the bottom is soldered a hollow metal inset which holds the tapered end of the porcelain lower support in place.

(*b*) *Calorimeter Cover.* Made of nickel-plated iron. It slips onto (*a*) snugly to a depth of $^3/_4$ inch. Its center is cut out and threaded to take a $1^3/_8$ inch pipe.

(*c*) *Heavy Copper Leads.* These are connected to the platinum leads by means of nickel screw connectors.

FIG. 10.—Metal calorimeter with furnace and thermocouple lead wires.

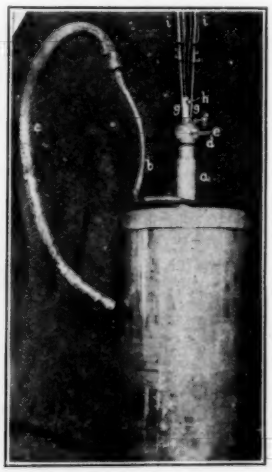

FIG. 11.—Metal calorimeter with cover stem showing excavating tube and partially insulated lead wires.

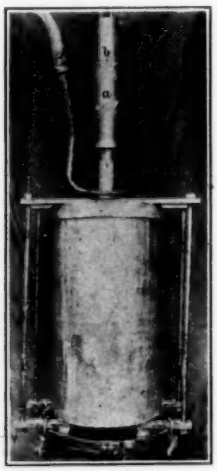

FIG. 12.—Calorimeter ready to be immersed in water bath.

(*d*) *Porcelain Insulators.* One millimeter bore and one millimeter wall.

(*e*) *Thermocouple.* Platinum, platinum-rhodium thermocouple, two feet long.

Description of Figure 11.—(*a*) *Cover Stem.* Made of nickel-plated copper, threads into calorimeter cover. It is $4^1/_4$ inches long and has a bore of $1^1/_8$ inches.

(*b*) *Copper Evacuating Tube.* Made of $^5/_{16}$-inch stock, and soldered into the cover stem about $^1/_4$-inch above the calorimeter cover.

(*c*) *Rubber Pressure Hose.* It connects the calorimeter to the vacuum pump, by way of the copper evacuating tube. It is coated with beeswax to make it air tight.

(*d*) *Threaded Collar.* Two inches in diameter, sweated onto the upper end of the cover stem.

(*e*) *Rubber Stopper.* This fits into top of cover stem.

(*f*) *Glass Tube Insulators.* These extend about 2 inches above the top of, and $^1/_2$-inch below the bottom of, the rubber stopper, and allow the heavy copper leads to pass through, and keep them apart for insulation purposes.

(*g*) *Heavy Copper Leads.* The same as shown in Fig. 10.

(*h*) *Porcelain Insulator.* Six millimeter bore and 2 millimeter wall. It passes through the rubber stopper and harbors the thermocouple, insulating it from the current lead wires. One wire of the thermocouple is strung with small bore porcelain insulators to insulate the two thermocouple wires from each other.

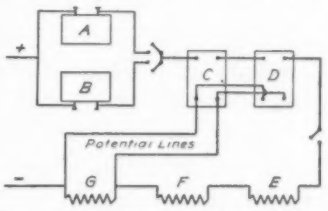

FIG. 13.—Electric wiring set up.

(*i*) *Current and Potential Leads.* To each heavy copper lead is attached, by means of a copper screw connector, two copper insulated leads, a heavy wire for the current, and a light wire, known as the potential lead wire, to be connected to the test meter.

Description of Figure 12.—(*a*) *Copper Extention Tube.* Copper Tube, $9^1/_4$ inches high and 2 inches in diameter that threads onto the collar of the cover stem. It is merely a protection for the wires from the surrounding water.

(*b*) *Water Level.* The water in the calorimeter bath reaches to level (*b*).

12. Electric Wiring Set Up. (Figure 13 Illustrates the Set Up.)—

(*A*) *Ammeter.* 0–10 ampere range.

(*B*) *Ammeter.* 0–50 ampere range.

(*C*) *Test Meter.* Revolution counter. Alternating current only.

(*D*) *Wattmeter.* Indicating wattmeter.

(*E*) *Rheostat.*

(*F*) *Rheostat.*

(*G*) *Electric Furnace.* Platinum wound furnace, operated on 110 volt alternating current circuit.

IV. Experimental Data Necessary for Calculating Specific Heats

In any range of temperature for which a run is made, the following data must be known:—

(1) The electrical energy expended in the resistance furnace.

(2) The heat absorption of the ice water used to counteract the rise in temperature of the bath.

(3) The temperature of the inflowing ice water.
(4) The temperature of the bath.
(5) The temperature of the material under investigation in the resistance furnace.

The following paragraphs describe the instruments used to obtain the above readings, and give their sensitivity and calibration, and all data and factors necessary for converting their readings to the purpose at hand.

13. Electrical Energy.—(*a*) *Portable Test Meter.* This instrument, of the induction coil type, is essentially a calibrated revolution counter. For the 10 ampere coil used in this work, the rating is 0.600 watthour per revolution, or 2160 watts per revolution. Allowing 4.186 watts to the calorie, gives the meter a value of 516.0 calories per revolution. The instrument was calibrated over its full range at 110 volts and found to be correct to better than 0.1%. At lower voltages and at the lowest wattages used in the experimental work, a comparison with an electrodynamometer type of wattmeter gave concordant results to within the accuracy of the comparison instrument of 0.1%.

(*b*) *Indicating Wattmeter.* It was found expedient to have an ordinary indicating wattmeter in the line, so that the wattage through the furnace could be seen at a glance, and easily controlled by means of the resistance in series with the furnace. A small amount of current is used in actuating the wattmeter, but as it is used in all runs for approximately the same wattages and for the same lengths of time, this correction is taken care of automatically.

14. Ice Water Heat Absorption.—(*a*) *Weighing the Overflow.* The run is started with the bath full and continuously stirred, and with the temperature of the bath constant. Ice water is allowed to flow in to keep the temperature of the bath constant, as heat is being transferred to the water from the calorimeter. The overflow is collected in cans, and for any range of temperature, the weight collected is equal to the weight of ice water delivered to the bath. The overflow is weighed to a gram.

Knowing the temperature of the ice water going into the bath, and the temperature of the overflow, the heat absorbed in this change in temperature is known. The total heat absorption of the ice water for the range of temperature can then be calculated.

Some of the ice water is utilized in counteracting the rise in temperature of the bath due to the heat caused by the friction of the stirrer in the bath.

(*b*) *Ice Water Correction for Stirring Friction.* After runs had been made on two days several months apart, the bath was allowed to be stirred for periods of four hours and the rise in temperature due to stirring noted. The increase in temperature amounted to 0.052° per hour.

On other occasions, the amounts of ice water necessary to lower the temperature of the bath 1°, were determined. In one case, 8442 grams

of ice water cooled the bath from 22.940° to 21.910°, with constant stirring for 30 minutes. As the raising of the temperature of the bath due to stirring is 0.026°, the true lowering of temperature of the bath is 22.940° + 0.026° — 21.910° = 1.056°. Hence at the average temperature of 22.425°, it requires 7994 grams of ice water to cool down the bath 1°. To counteract one hour of stirring at 22.425° requires 7994 × 0.052 = 416 grams of ice water.

At the average temperature of 27.587° it requires 6554 grams of ice water to cool down the bath 1°. At 27.587°, one hour of stirring will be counteracted by 341 grams of ice water. The ice water used in all experiments had a temperature of 0°.

By plotting these results the ice water stirring correction for any temperature of the bath can be found by inspection.

(*c*) *Heat Capacity of Water.* By means of an electrical continuous flow method, Callendar[1] and Barnes[2] have found the specific heat of water over the range of 0° to 100°. Callendar gives the variation of total heat h, with the temperature t, in the form of an equation that is of great value in the present work, for it is necessary to know the heat capacity of the ice water used to keep the temperature of the bath constant.

$$h - t = 1.1605 \log_{10}\left(\frac{t+20}{20}\right) - 1.1464\left(\frac{t}{100}\right) + 0.42\left(\frac{t}{100}\right)^2 + 0.30\left(\frac{t}{100}\right)^3$$

Thus the heat absorbed by one gram of ice water in changing its temperature from 0° to 23.560° amounts to 23.709 calories.

(*d*) *Heat Capacity of the Bath and Contents.* From preliminary experiments it was determined to be 180,440 calories.

15. Temperature of the Ice Water.—A long range mercury thermometer has its bulb in the overflow box of the tube water cooler. It measures the temperature of the ice water flowing into the calorimeter bath. The thermometer was compared with a French Standard, certified by the Bureau of Standards, and was found to be correct at 0°. There is no difficulty in having a continuous supply of ice water at 0°, with the arrangement used, provided constant attention is given to it.

16. Temperature of the Bath.—The temperature of the bath is read by means of a Beckmann thermometer graduated in hundredths of a degree, and calibrated against a thermometer recently certified by the Bureau of Standards. The bulb is situated near the overflow and measures its temperature. The temperature of the room is regulated so as to coincide with the temperature of the bath to within a few tenths of a degree.

[1] H. L. Callendar, *Proc. Roy. Soc.* (London), **86A,** 254–7 (1912).

[2] H. T. Barnes, *Trans. Roy. Soc.* (London), **199A,** 149–263 (1902).

17. Temperature of the Material in the Furnace.—The junction of a two-foot platinum, platinum-rhodium thermocouple is imbedded in the center of the material which is being heated in the furnace. The two ends of the couple extend one inch above the top of the cover of the calorimeter bath. They are connected to a Leeds and Northrup potentiometer by copper leads. A thermometer hanging just above the bath measures the cold junction temperature, which is corrected in the temperature measurements. The thermocouple and potentiometer were calibrated against the freezing points of pure metals supplied by the Bureau of Standards for such work, and the deviations in temperature were plotted as suggested by Adams.[1]

V. Heat Insulation

18. Furnace Insulation.—From preliminary work, it was found that the heat loss from the furnace had to be reduced as far as possible. The advantage in decreasing the input of electrical energy was in increasing the fraction of heat expended on the material. This was accomplished (*a*) by running the furnace under vacuum conditions instead of at atmospheric conditions, and (*b*) by packing the furnace core with a good insulating material. In order to reach 1100° under atmospheric conditions, about 750 watts from a 12–15 ampere current had to be expended, whereas with the present vacuum furnace, 350 watts from an 8-ampere current will give 1200°. The maximum current capacity of the test meter is 10 amperes.

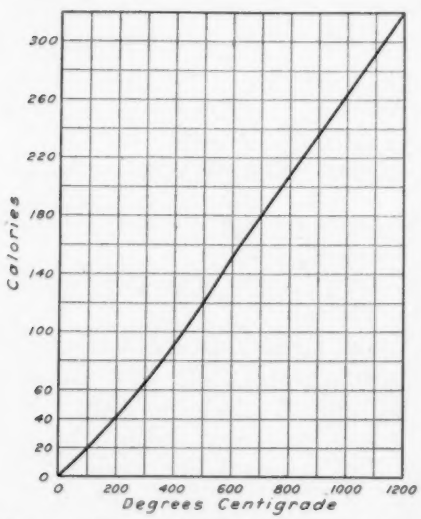

FIG. 14.—Heat capacity of 1 gram of quartz calculated from White's results.

It has been found that fused zirconia has the lowest specific heat (0–100°, 0.1075)[2] and heat conductivity (about 0.00039)[3] of any material suitable for furnace packing.

19. Bath Insulation.—The calorimeter bath is covered on its sides, top and bottom with two-inch felt to minimize heat exchange with the room. The temperature of the room was kept to within a few tenths of a degree of the temperature of the

[1] Leason H. Adams, "Symposium on Pyrometry," *Am. Inst. Mining Met. Eng.*, 165–78 (1920).

[2] J. W. Marden and M. N. Rich, Bur. Mines, *Bull.* **186,** 20 (1921).

[3] R. S. Hutton and J. R. Beard, *Proc. Faraday Soc.*, **1,** 266 (1905).

bath so as to minimize the radiation exchange. The felt is covered with oilcloth to prevent it from getting wet.

20. Insulation for the Ice Water System.—The ice water tank and the tube water cooler are covered on all sides with two-inch felt.

The valve and pipe connections between the ice water tank and the tube water cooler are very heavily covered with felt. The connection between the tube water cooler and the bath is a vacuum tube, which is also well covered with felt and oilcloth. The vacuum tube, set at an angle of 30°, is connected by rubber hose to the overflow box in the tube water cooler, and leads the ice water directly into the tube stirrer in the bath by means of another piece of rubber hose.

VI. Preparation for an Experiment

All of the parts of the apparatus mentioned in this chapter are described in Chapter II, and are illustrated in the figures accompanying it.

21. Preparation of the Sample.—If the material is inert like quartz, the crushed particles are filled into the platinum container. If the material is a clay, which is finely divided and contains water of combination, it must first be molded.

The clay is made to pass a 20-mesh screen, and then worked with water until a plastic mass is obtained. The mass is then put into a screw press and forced through a $1^1/_2$-inch orifice. The stiff column is cut up into pieces 1 to 2 inches long. Half of these pieces are then centrally bored with a $^5/_{16}$-inch cork borer. All of the pieces are allowed to dry at 110° over night. The solid pieces with a total length of 4 inches are trimmed down to fit the platinum container snugly. The hollow pieces are trimmed down to fit the container, and are also hollowed out to allow the porcelain thermocouple protection tube to slide through them. The container is then filled up with these hollow sections, and the protection tube is slipped into place.

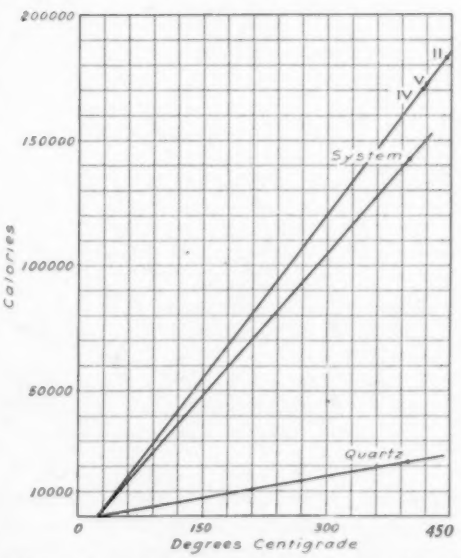

FIG. 15.—Quartz runs and heat capacity of system in range 23.560–420°C. Heat capacity of system 23.560–400° = 142,400 calories.

22. Assembling the Calorimeter.—The platinum container and its charge are then slipped into the furnace core, so that it stands on the false bottom consisting of a thin alundum disc resting on a porcelain ring. The furnace core is slipped into the alundum cylinder, which is surrounded by the zirconia packing, held in place by the porcelain cylinder, with the nickel cylinder on the outside. The weight of the furnace parts are:—

	Grams
Nickel and porcelain cylinders	1406.0
Zirconia packing	1321.0
Alundum cylinder	220.8
Alundum core	205.3
Platinum container	51.0

The nickel cylinder and contents are now ready to be set onto the porcelain bottom support which is in its holder in the base of the metal calorimeter. The porcelain upper support is now put on, and then the metal cover of the calorimeter is forced on.

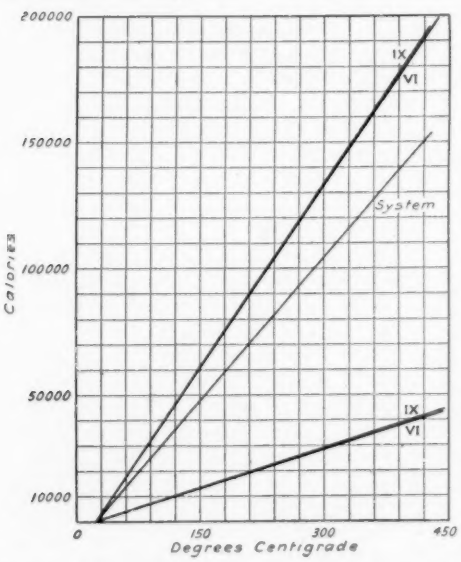

FIG. 16.—Heat capacity of A-I English china clay 247.5 grams in range 24–420°C. VI, 23.560–422° = 41,400 calories; IX, 23.560–415° = 41,000 calories.

The lead ends of the platinum resistance wire are now sheathed with the porcelain protection tubes, and are attached by nickel screw connectors to two bare heavy copper leads. The cover stem, provided with a roll of dehydrated mica that fits snugly on the inside, is then slipped over the copper lead wires and screwed into place, thereby holding the porcelain upper support in position by its extension below the cover.

A rubber stopper fitting into the cover stem carries in it two short glass tubes through which the heavy copper leads can just pass, and also carries a porcelain protection tube through which the thermocouple wires are led. When the rubber stopper is in place, its porcelain protection tube just touches the porcelain tube that is inserted in the material. The thermocouple is now inserted into place, its two wires being insulated from each other by small porcelain insulators. The copper lead wires are strung with glass tubing and are held in position so that there can be no short circuiting.

The two openings through which the lead wires enter the glass tubes in the stopper, and the openings whereby the thermocouple wires enter the porcelain protection tube, are now sealed with De Khotinsky cement. All other joints are made vacuum tight by painting them with a heavy layer of beeswax. To each heavy copper lead are attached by means of a copper screw connector, the two lengths of insulated copper wire. The screw connectors are insulated with rubber tape. The copper extension tube is now slipped over the four insulated lead wires and over the separately insulated thermocouple wires, and threaded into place. The joint is made water tight with a layer of beeswax. The apparatus is clamped into its metal frame and is ready for immersion in the bath.

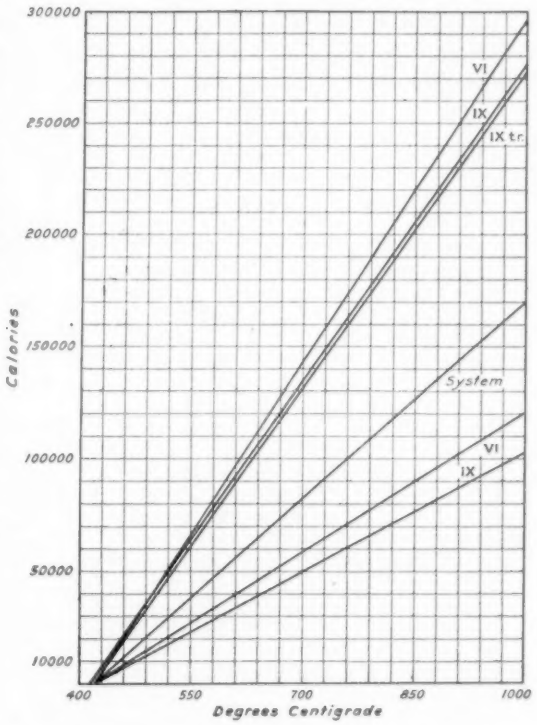

FIG. 17.—Heat capacity of A-I English china clay 247.5 grams range 400–900°. VI, 421–900° = 121,200 calories; IX, 421–900° = 103,200 calories.

23. Evacuating the Calorimeter.—The calorimeter bath is filled with water and the calorimeter set in the middle of it. The cover is put on so that the six wires from the calorimeter pass directly through the central tube. The rubber hose attached to the calorimeter is connected to the vacuum pump. The lead wires are connected to the source of current and the instruments, and the thermocouple wires are connected to the potentiometer.

The vacuum pump is started and the system is evacuated for several hours, to get rid of adsorbed air. The pressure is then usually below a millimeter. The pump is then shut off, and the system allowed to remain evacuated.

24. Ice Water Supply.—On the day before a run is to be made, the ice water tank is filled with water and crushed ice and stirred continuously. The tube water cooler is filled with crushed ice. From time to time the ice is shaken down and packed around the coil to insure intimate contact.

This process of packing and refilling is made every half hour during the run. The thermometer in the overflow box records the temperature of the ice water. During the run, the ice water tank is frequently supplied with water and ice, to keep the head of water on the valve constant. Usually about 600 lbs. of ice are sufficient for the complete run.

VII. Experimental Procedure

25. Ascending Temperatures.—When the calorimeter bath is stirred and filled just to overflowing, and the temperatures of the bath and room are the same, with the ice water supply at 0°, and the vacuum pump working smoothly, the test meter is read and a tarred can placed under the overflow. The current is turned on, and the resistance in the circuit varied to give the required wattage through the furnace. The wattage is continuously watched and kept constant, for from preliminary work it is known that this wattage will raise the furnace temperature the required amount.

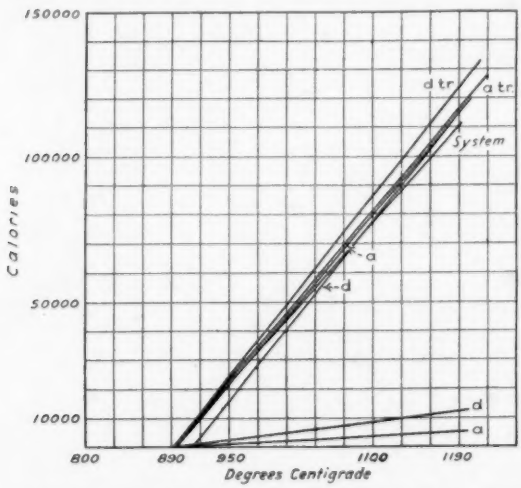

FIG. 18.—Heat capacity of A-I English china clay 216.2 grams in range 900–1200°C. IX, Ascending temp. (*a*) 892–1187° = 5,200 calories. Descending temp. (*d*) 1187–892° = 12,200 calories.

The temperature of the bath is kept constant by varying the ice water flow into the bath. Normally the fluctuation of the temperature can be controlled to ±0.01°. The test meter readings are recorded. If the material being heated is a clay, the pressure developed in the furnace is recorded with the corresponding temperature of the clay. If the substance being heated is an inert material like quartz, a pressure in the calorimeter is artificially developed by working the pinchcock attached to the stopcock tube in one arm of the double L-tube in the vacuum system. The pressure curve followed is that of the clays at corresponding temperatures, thus making the heat insulation for the quartz run equivalent to the heat insulations found for the clay runs.

When equilibrium has been attained, that is when the furnace temperature has reached its maximum, the exchange of heat between the calorimeter and the ice water inflow is balanced. In practice, the equilibrium is considered to have been attained, when the rise in temperature of the

furnace, in the neighborhood of the maximum temperature, is even and very slow, in the order of $^1/_2°$ a minute. When this stage has been reached, the furnace temperature and test meter readings are recorded, and the overflow can replaced by an empty one, as soon as the temperature of the bath coincides with the initial temperature of the run. The wattage is then increased and the procedure repeated for the second range of the run.

The data obtained are then the total electrical energy consumed in the furnace, the total weight of ice water used, and the temperature to which the material has been heated. The weight of the material, the temperature of the ice water and of the bath, are already known. Similar data are found for each stage of the run.

With clays the main dehydration period exists between 420° and 900°, making it necessary to have this range all in one stage of the experiment. This then limits the run to three stages for the ascending temperatures. With 90–110 watts 420° can be reached in the furnace; then increasing to 200–240 watts will raise the temperature to 900°, and finally increasing to 300–350 watts, will give 1200° as the maximum temperature.

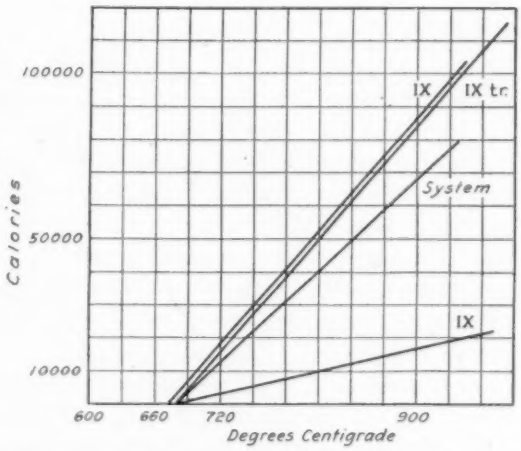

FIG. 19.—Heat capacity of A-I English china clay 216.2 grams in range 900–700°C. IX, 912–679° = 17,500 calories.

26. Descending Temperatures.—At the end of the last ascending temperature range, when equilibrium has been reached, the current is cut off, and the heat given up by the calorimeter to the bath is balanced by ice water. The temperature falls fast and continuously.

The descending run is divided into two stages, roughly 1200–900°, and 900–700°, the only data being obtained, are the quantities of ice water used for each descending range of temperature.

VIII. Heat Capacity of the "System"

27. Heat Capacity of Quartz.—The quartz used in the calibration runs was a Baker and Adamson product of crushed crystals, analyzing 99.98% SiO_2, and having indices of refraction 1.544–1.553, and a specific gravity of 2.654.

The heat capacity of the quartz was calculated from the results of White,[1] in Fig. 1, to give the values for one gram of quartz as represented graphically in Fig. 14. By plotting a similar curve for 251 grams of quartz, the weight used in the calibration runs, the heat capacity of the quartz between any two temperatures in the ranges 24–420°, 420–900°, 900–1200°, 1200–900°, and 900–700°, can be easily obtained and used for deriving the heat capacity of the "system."

28. Heat Capacity of the "System."—Several calibration runs were made with the quartz, and the net heat absorbed in raising the temperature of the quartz and the "system" through the ranges mentioned above were calculated from the data on electrical energy input, the quantity of ice water used to keep the temperature of the bath constant, and from the stirring-friction ice water correction. These results of the net heat absorbed, in all of the ranges of temperature for the calibration experiments, do not differ in duplicate runs by more than $\pm 1\%$. The steps in the calculations are very similar to those made for the clays.

The net heat absorptions obtained in each temperature range are plotted with the calculated heat absorption for the quartz, an example being given in Fig. 15. The experimental data curves are marked with Roman numerals. In most cases the initial temperatures in the various ranges covered by the calibration runs and by the experimental clay runs are different, and for calculating purposes their corresponding curves have to be transposed parallel to themselves to pass through a common origin. Such transposed curves are marked "tr" on the figures. Where distinction has to be made between ascending and descending temperature curves, they are accordingly designated "a" and "d" on the figures.

By subtracting graphically the calculated heat absorption of the quartz from the heat absorption of the combined quartz and "system," determined experimentally, the heat capacity of the "system" is obtained, and its curve is marked accordingly.

These "system" curves are then used for obtaining the heat absorption of the clays, by subtracting them from the net heat absorption values, determined experimentally for the clays and the "system" in the requisite ranges of temperature. The resultant data are:

HEAT CAPACITY OF THE "SYSTEM"

Temperature range		Calories	Cal. per 1°
23.560–400°		142,400	379
421–900°		170,079	355
892–1187°	ascending and descending	109,778	372
892–679°		65,317	307

[1] W. P. White, *loc. cit.*

IX. Experimental Data for the Heat Absorbed and Evolved by Clays during Firing and Cooling

29. A-1 English China Clay.—The following are the detailed experimental data and the resulting calculations for duplicate runs VI and IX, made on 247.5 grams of air dried A-I English china clay:

(*a*) *Range 24–420°*

		Energy input		
Run	Temp. interval	Revolutions	Ice water, grams	Duration in hours
VI	23.560–422°	461.30	3,086	2.93
IX	23.560–415°	452.70	2,954	2.75

The net heat energy used is then obtained:

		Energy in calories		
Run	Temp. interval	Electrical	Ice water	Net
VI	23.560–422°	238,030	45,379	192,651
IX	23.560–415°	233,594	43,956	189,638

The net heat energy absorbed is represented in Fig. 16 as the upper curves marked VI and IX. The curve marked "system" is transposed from the quartz calibration curves. By subtracting the "system" curve from the upper curves, the lower curves are obtained, these representing the heat absorbed by the clay alone. Numerically the data are:

		Heat absorption in calories	
Run	Temp. interval	Total	Per gm. per deg.
VI	23.560–422°	41,400	0.420
IX	23.560–415°	41,000	0.423
			Av. 0.422 ± 0.002

(*b*) *Range 420–900°*

		Energy input		
Run	Temp. interval	Revolutions	Ice water, grams	Duration in hours
VI	422–894°	2748.00	50,956	8.33
IX	415–895°	2787.00	52,217	7.80

The net heat input is:

		Energy in calories		
Run	Temp. interval	Electrical	Ice water	Net
VI	422–894°	1,418,000	1,129,200	288,800
IX	415–895°	1,438,100	1,164,000	274,100

The curves for the net energies are given in Fig. 17. The net results differ from the average value by ±3%. The values for the heat absorbed are:

		Heat absorption in calories	
Run	Temp. interval	Total	Per gm. per deg.
VI	421–900°	121,200	1.022
IX	421–900°	103,200	0.871
			Av. 0.947 ± 0.075

(c) *Range 900–1200°*

Run	Temp. interval	Energy input: Revolutions	Energy input: Ice water, grams	Energy input: Duration in hours
VIa	894–1186°	774.82	12,606	1.42
IXa	895–1187°	897.53	15,402	1.68
IXd	1187–912°	....	5,025	0.55

These results may be summarized:

Run	Temp. interval	Energy in calories: Electrical	Energy in calories: Ice water	Energy in calories: Net
VIa	894–1186°	399,810	235,410	114,400
IXa	895–1187°	463,130	349,230	113,900
IXd	1187–912°	.....	113,920	113,920

The curves corresponding to the net energy consumption are given in Fig. 18.

Between 892° and 1186° the ascending curves VIa and IXa vary only by 500 calories in 115,000, or a difference of $\pm 0.21\%$. On subtracting the heat absorption for the "system," the total heat absorptions for the clay differ by 500 calories, which now represents a difference of $\pm 4.6\%$.

The weight of the dehydrated material in run VI was 216.8 grams and in run IX 216.2 grams corresponding to losses of weight of 12.40% and 12.65%, respectively. The heat absorption and evolution are calculated per gram of air dried clay, and per gram of dehydrated clay.

Run	Temp. interval	Heat absorption in calories: Total	Heat absorption in calories: Per gram air-dried clay per deg.	Heat absorption in calories: Per gram dehydrated clay per deg.
VIa	892–1186°	5,700	0.078	0.089
IXa	892–1187°	5,200	0.071	0.082
			Av. 0.075	0.086
			±0.004	±0.004
		Heat evolution in calories		
IXd	1187–892°	12,200	0.167	0.191

(d) *Range 900–700°*

Run	Temp. interval	Energy input ice water, grams	Duration in hours	Net heat in calories
IX	912–673°	4,136	0.75	90,948

The corresponding curve is given in Fig. 19:

Run	Temp. interval	Heat evolution in calories: Total	Heat evolution in calories: Per gram air dried clay per deg.	Heat evolution in calories: Per gram dehydrated clay per deg.
IX	912–679°	17,500	0.303	0.347

(e) *Average Heat Absorption and Heat Evolution*

To heat 1 gram of air-dried A-I English china clay from 25° to 1200° requires 644 calories.

TABLE IV

HEAT ABSORBED AND EVOLVED BY CLAY DURING FIRING AND COOLING

(For the first two clays the values given are the average results of two independent experiments and the deviations from this average are indicated)

Clay type	Loss on ignition, per cent	Heat absorbed per gram per degree on heating the air-dried (110°) clay over the temperature ranges given				Heat evolved per degree on cooling the resulting quantity of fired clay			Specific heat of the fired clay cal./gm., 1200–700°	Dehydration period		
		25–420°	420–900°	900–1200°	25–1200°	1200–900°	900–700°	1200–700°		Pressure rises	Period of maximum pressure, 20 mm.	Pressure falls to 3 mm.
N. Car. Kaolin.....	14.0	0.49	0.69	0.23	0.50	0.23	0.28	0.24	0.28	25° to 460°	460° to 570°	570° to 780°
		±0.07	±0.05	±0.01	±0.035	±0.01	±0.06	±0.05	±0.05			
A-1 English China....	12.5	0.42 ±0.01	0.95 ±0.07	0.075 ±0.004	0.55 ±0.07	0.17	0.31	0.20	0.23	25° to 480°	480° to 540°	540° to 760°
Tenn. Ball No. 5.....	13.8	0.47	0.53	0.51	0.51	0.20	0.33	0.25	0.29	25° to 470°	470° to 550°	550° to 830°
Laclede-Christy Raw Flint.....	13.0	0.47	0.68	0.24	0.50	0.17	0.37	0.25	0.29	25° to 470°	470° to 630°	630° to 850°
Average.....		0.46			0.51	0.19	0.32	0.24	0.27			

Temp. interval	Calories
25–420°	395 × 0.422 × 1.00 = 167
420–900°	480 × 0.947 × 1.00 = 455
900–1200°	300 × 0.086 × 0.87 = 22
	Total 644

The average heat absorption per degree for A-I English china clay between 25° and 1200° is then 0.55 calories.

One gram of A-I English china clay, heated to 1200°, will evolve heat, on cooling, as follows:

Temp. interval	Calories
1200–900°	300 × 0.191 × 0.87 = 50
900–700°	200 × 0.347 × 0.87 = 60
	Total 110

or an average heat evolution of 0.22 calories per degree between 1200° and 700°.

30. Tennessee Ball Clay No. 5.—250.9 grams of air-dried clay were used, the results being given in Table IV. The heat absorbed in the ascending temperature range 900–1200° was large, part of the heat being absorbed by gaseous reactions. This assumption is substantiated by the gas pressure developed in the furnace, the foul smell of decomposed organic matter issuing from the vacuum pump, and the black appearance of the burned clay indicating organic matter.

31. North Carolina Kaolin.—Duplicate runs on 219.6 grams of clay were made, there being no unusual features to record.

32. Laclede-Christy Raw Flint Clay.—303.4 grams of clay were employed. A small gas pressure was developed in the ascending temperature range 900–1200°, probably explaining the increase in heat absorption as compared with the heat evolution in cooling over the same range of temperature.

X. Summary and Conclusions

The numerical results obtained are displayed in Table IV. They represent the data obtained for four types of clays.

33. Conclusions.—The following points and conclusions are brought out by the data presented in the table:

(1) All four clays contain approximately the same amount (14%) of moisture in the air dried condition.

(2) During the initial period of heating (up to 420°), in which all of the hygroscopic and some of the chemically combined water is driven out all of the clays absorb approximately the same amount of heat, 0.46 calories per gram per degree.

(3) Between 420° and 900° the remainder of the chemically combined water is driven out, most of it between 470° and 600°. During this period two of the clays, the North Carolina kaolin and the flint clay, show the same heat absorption, about 0.7 calorie per gram per degree. The other two clays behave differently, the English china absorbing 0.95 and the Tennessee ball only 0.53 calorie per gram per degree.

(4) During the final or finishing period 900° to 1200°, the North Carolina kaolin and the flint clay again exhibit similar behavior, each absorbing about 0.2 calorie per gram per degree. The English china clay, however, absorbs only 0.075 calorie per gram per degree over this range. Since this is less than the specific heat of the fired clay (0.17) in this temperature range, it shows that some reaction is taking place which evolves heat. Over the same range the Tennessee ball shows a heat absorption of 0.51 calorie per gram per degree and by a similar process of reasoning this clay is evidently undergoing some reaction which absorbs heat.

(5) Over the whole firing period all four clays behave alike as regards the total heat which they absorb during the firing operation, the heat absorption amounting to 0.5 calorie per gram per degree.

(6) Stated in another way, the amount of heat which must be put into the clay ware in order to completely fire it, if the finishing temperature is 1225° amounts to 1200 × 0.5 or 600 calories per gram of bone dry body.

(7) If, however, the heat content of the fired ware is utilized during cooling (as, for example, to heat the air for a drier) the net heat required by the various reactions which occur in the clay during the firing operation is 1200 × (0.51–0.24) or 320 calories per gram of bone dry body; or, stated in another way, 1 gram bone dry clay at 25° = 0.86 gram fire clay at 25° + 0.14 gram water vapor at 25°–320 calories.

(8) If we subtract from these 320 calories the heat required to vaporize the 0.14 gram of water present (*i. e.*, 77 calories), the remainder, about 240 calories, represents the heat absorbed by the dehydration reaction (at room temperature to produce liquid water) plus the net heat absorbed by all of the other chemical reactions which occur during the firing (also at room temperature).

(9) The results given above supply for the first time reliable data on the heat absorption of clay in a form suitable for use in heat-balance calculations.

(10) No attempt has as yet been made to correlate the above results with the burning behavior of these clays.

The results here presented of course apply strictly only to the four clays investigated. Moreover, they should be looked upon as the initial results in an entirely new field of investigation. They represent a new type of

calorimetric work and their principal value is the indication which they give of the possibilities in this field.

Incidentally it may be pointed out that the calorimetric method developed in connection with this investigation can be used to determine the heat effects of other high temperature processes such, for example, as the heat of fusion of a glass batch or the heat absorbed in manufacturing cement clinker.

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ABBREVIATIONS USED IN INDEX

abs.	absolute
a. c.	alternating current
alk.	alkaline
amt.	amount
anal.	analysis
anhyd.	anhydrous
app.	apparatus
approx.	approximate, approximately
at. wt.	atomic weight
av.	average
b. p.	boiling point
B. t. u.	British thermal units
bldg.	building
Brit.	British
cal.	calory(ies)
calc.	calculate
calcd.	calculated
calcg.	calculating
calcn.	calculation
Can.	Canada
cc.	cubic centimeters
ceram.	ceramics
charac.	characteristics
chem.	chemical (not chemistry)
cm.	centimeter(s)
circ.	circular
Co.	Company
Comm.	Committee
coeff.	coefficient
compd.	compound
compn.	composition
concd.	concentrated
concn.	concentration
condy.	conductivity
const.	constant
contd.	contained
contg.	containing
c. p.	chemically pure
cryst.	crystalline (not crystallize)
crystd.	crystallized
cu. m.	cubic meter(s)
d.	density
d. c.	direct current
decompn.	decomposition
det.	determine
detd.	determined
detg.	determining
detn.	determination
dil.	dilute
econ.	economical
ed.	educational
elec.	electric, electrical
e. m. f.	electromotive force
equil.	equilibrium
equiv.	equivalent
est.	estimate
estd.	estimated
estg.	estimating
estn.	estimation
evap.	evaporate
evapd.	evaporated
evapg.	evaporating
evapn.	evaporation
examd.	examined
examg.	examining
examn.	examination
expt.	experiment
exptl.	experimental
ext.	extract
extd.	extracted
extg.	extracting
extn.	extraction
f. p.	freezing point
ft.	foot, feet
fund.	fundamental
fur.	furnace
gen.	general
g.	gram(s)
htg.	heating
h. p.	horsepower
hr.	hour
in.	inch(es)
indus.	industrial
inorg.	inorganic
insol.	insoluble
invest.	investigation
kg.	kilogram(s)
kw.	kilowatt(s)
l.	liter(s)
lab.	laboratory

lb.	pound(s)
lit.	literature
mach.	machinery, machine
mat.	material
met.	metallurgy, metallurgical
m.	meter(s)
manuf.	manufacture
max.	maximum
mfg.	manufacturing
meas.	measure, measurement
mech.	mechanical
mg.	milligram
min.	minute(s)
mixt.	mixture
mol.	molecule, molecular
mol. wt.	molecular weight
m. p.	melting point
N.	normal
org.	organic
operg.	operating
opern.	operation
oper.	operate
p. d.	potential difference
phys.	physical
physiol.	physiological
Port.	Portland
powd.	powdered
prac.	practical
ppt.	precipitate
pptd.	precipitated
pptg.	precipitating
pptn.	precipitation
press.	pressure
prep.	prepare
prepd.	prepared
prepg.	preparing
prepn.	preparation
prob.	problem
qual.	qualitative
quant.	quantitative
recrystd.	recrystallized
ref.	reference
refrac.	refractory
rept.	report
resist.	resistance
resis.	resisting
resp.	respectively
r. p. m.	revolutions per minute
sat.	saturate
satd.	saturated
satg.	saturating
satn.	saturation
sec.	second(s)
scien.	scientifically, scientific
sep.	separate
sepd.	separated
sepg.	separating
sepn.	separation
sol.	soluble
soln.	solution
soly.	solubility
sp.	specific
sp. gr.	specific gravity
sq. cm.	square centimeter(s)
specif.	specifications
stand.	standard
subs.	substance
temp.	temperature
tent.	tentative
v.	volt(s)
vol.	volume (not volatile)
wt.	weight

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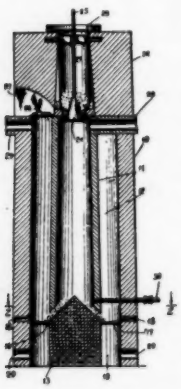
Abrasives

PATENTS

1. Aluminous abrasive and method of making the same. HAROLD A. RICHMOND and ROBERT MACDONALD, JR. U. S. 1,467,590, Sept. 11. In the manuf. of artificial corundum the improvement which consists in regulating the percentage of titanic anhydride in it to control the resist. to fracture and to adapt it to various grinding and polishing operations while providing appreciable quantities of both silica and iron oxide in the product.

2. Method of making abrasive articles of manufacture and product. FRANK JOSEPH CRUPI. U. S. 1,468,960, Sept. 25. The herein described method of making abrasive manufactures consisting in coating a backing with a solution of glue; in applying abrasive material to the glue coating; in coating the glue and abrasive coating with a colloidal, waterproof, adhesive composition containing rosin, glue, phenol, acetic acid and water in about the proportions stated, and in which the acids prevent coagulation of the glue.



3. Apparatus for the manufacture of aluminum chloride. FRANK W. HALL. U. S. 1,468,632, Oct. 2. App. for the manuf. of aluminum chloride comprising a retort, a combustion chamber about the retort adapted to supply heat thereto, a discharge outlet from the retort to the combustion chamber and means for maintaining ash from the retort about said outlet so as to form a gas-tight seal.

4. Segmental abrasive wheel. WALLACE W. GREENWOOD. U. S. 1,469,723, Oct. 2. A grinding wheel comprising a cylindrical drum adapted to be mounted concentrically on the wheel spindle, abrasive segments mounted thereon and forming a cylindrical grinding surface, each of said segments having a projecting lug on an inner portion, and clamping means including a removable wedge to engage said lug with adjustable press. and replaceably fasten the segment to said drum.

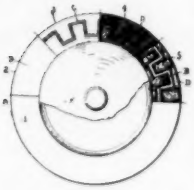
Art

5. Greek terra cottas. M. E. P. *Bull. Met. Mus. Art*, **18** [9], 212(1923).—Seven examples of Greek koroplastic art lately acquired for the Museum are described. Illus.

ED.

6. The trend in modern American ceramics. ERNESTINE EVANS. *Shadowland*, **7** [2], 58(1923).—A few of the eminent painters are turning to the potter's craft in their search for a new medium, thus overcoming the danger of the *commonplace* in American pottery.

ED.



PATENT

7. Manufacture of ornamented ware. JOHN B. LESSELL. U. S. 1,467,111, Sept. 4. The method of treating the surfaces of glass, pottery, porcelain, metal, and like articles, which consists in applying to the article, a mat. of selected outline which will not fuse, applying thereon and over the said mat. a fluid containing the desired coloring matter, firing the article to fuse the coloring matter, and then removing the said mat. and coloring matter thereon from the article.

Cement, Lime and Plaster

8. Italian cement plants. R. M. *Rev. Mat. Constr. Trav. Pub.*, **166**, 160–2(1923).—Detailed list of the important 48 concerns, controlling about 70 plants, that manuf.

natural cement and Port. cement, giving their individual annual production, their main products, and the numbers and types of fur. in use. The total production amts. to 1,700,000 short T. annually. Their mechanical equipment is mainly of Ger. origin L. N.

9. Franco-Belgian association for testing materials. Session of June 23, 1923. H. C. *Rev. Mat. Constr. Trav. Pub.*, **166**, 165–7(1923).—*Influence of low temperature on the hardening of mortars, after setting.* (Mr. Baire.) Specimen of 5 cm. cubes, made of cements and mortars were inclosed, after setting, in soldered zinc containers. One set of containers were put in an ice-making calcium chloride bath, having an av. temp. of —6° to —8° C. The other set was kept at an av. temp. of +14°. At various time intervals containers were opened and the specimens tested. The following are results for a mortar of an aluminous cement:—

	Days				
	1	2	3	7	28
Tensile Strength					
Temp. Normal	17.5	20.5	19.7	25.2	28.2
Temp. below freezing	17.5	17.5	18	20.2	20.5
Compressive Strength					
Temp. Normal	165	215	275	340	385
Temp. below freezing	165	195	212.5	260	255

It is concluded that low temp. affects the hardening of hydraulic binders, due to the effect of temp. on chem. reactions, and that the variation in resistance between specimens held at different temps. depends upon the binder, the fused cement being relatively less influenced by low temps. than slag cement. L. N.

10. Concrete-lined pipes. Anon. *Indus. Australian & Mining Standard*, **70**, 280(1923).—A process has been devised by a Brit. firm for applying a lining of concrete to cast iron pipes, thereby eliminating the formation of deposits even from bad water. This is accomplished by a new mach. in which the pipe to be lined is rotated at high speed so that the concrete is driven into place by centrifugal force. A lining from $^1/_2$″ to 1″ in thickness is obtained according to requirements, and pipes of all diam. from 4″ to 72″ have been lined successfully. O. P. R. O.

11. Quick-setting cement. Anon. *Can. Eng.*, **45**, 362(1923).—Tests have been made with *ciment fondu* at the Conservatoire Nationale des Arts et Metiers with a view to fixing safe working stresses for this mat. when used for reinforced concrete. Up to the present the same amt. has been used, as if Port. cement were used, but these expts. show that not nearly as much is required. The mixt. used in the expts. consisted of 800 l. of gravel, and 400 l. of sand, mixed with 300 kg. of Port. cement, and with either 300 kg. or 200 kg. of *ciment fondu*. Cubes made with the Port. cement tested at 3 mos., broke under a load of 155 kg. per sq. cm., while at 6 mos. the strength had risen to 163$^1/_2$ kg. per sq. cm. Corresponding cubes of concrete had at 3 days a strength of 324 kg. per sq. cm., which in 3 mos. had risen to 362$^1/_4$ kg. per sq. cm. Hence at 3 days the strength was equal to that of the Port. cement concrete at 3 mos. With the weaker mixt., contg. 200 kg. of *ciment fondu*, the strength at 3 days was 242 kg. per sq. cm.; at 3 mos., 252 kg. per sq. cm., and at 6 mos., 257 kg. per sq. cm. O. P. R. O.

PATENTS

12. Manufacture of artificial stones. Anon. Ger. Pat. 144,706. According to this invention light and highly porous bodies produced from blast fur. slags and similar scoriae, with the addn. of lime or cement to act as a binding agent, are hardened by the action of either low or high press. steam immediately after molding and setting according to the preliminary setting thereof. (*Quarry & Surv. & Contractors' Jour.*) O. P. R. O.

13. Hardened water-repellent gypsum plaster and method for producing the same. JOSEPH W. EMERSON. U. S. 1,470,260, Sept. 25. An article of manufacture comprising "set" or hydrous gypsum plaster, the pores of which are substantially filled with sulphur.

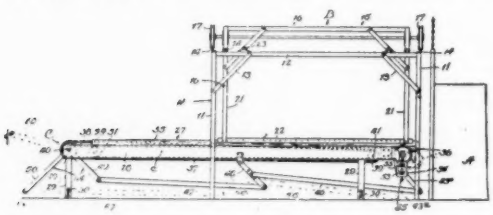
14. Electrical cement. ALAN P. SULLIVAN. U. S. 1,468,930, Sept. 25. An elec. cement comprising more than 80% of copper powder together with magnesium chloride and magnesium oxide.

Enamel

PATENTS

15. Process for removing enamel from old and new enameled articles. H. ADLER. Ger. pat. 374,114, Jan. 17, 1922. Iron shot, quartz, sand, or the like, is forced through steel tubes by compressed air on to the surface of enameled articles contd. in a closed chamber. (*Jour. Soc. Chem. Ind.*) O. P. R. O.

16. Removal of scale and rust from iron and steel. HARRY N. HOLMES. U. S. 1,470,225, Sept. 25. The method of removing rust or scale from iron or steel, consisting in pickling the same in an acid bath containing at least one-fifth of 1% by volume of an aldehyde to inhibit the attack of the acid upon the base metal.



17. Charging apparatus for enameling furnaces. WILLIAM HOGENSON. U. S. 1,468,944, Sept. 25. Charging app. for enameling fur., comprising in combination, a carriage having a removable work carrier, a furnace charging fork, arranged to receive said work carrier when the latter is moved over said charging fork, tracks, for supporting one end of the fork, and depressible rollers for supporting the other end of the fork.

18. Enameling. K. WARGA. Brit. 191,771, Aug. 16, 1921. Multicolor decorations, designs, lettering, etc., are printed on surfaces of Al or Al alloy and enameled. Films comprising mixts. of mineral colors or pigments and vitreous flux with a liquid or viscous vehicle are printed successively on the metal surface, the melting points of the mixts. being so arranged that the mixt. adjacent the metal surface has the lowest m. p. and the m. p.'s of the successive films rise progressively. The metal surface is oxidized prior to printing and the films are fixed by firing in a kiln in which a temp. corresponding to the highest m. p. is maintained. (*C. A.*)

Glass

19. On the relation between the composition and chemical resistance and chemical attack of glass. G. KEPPELER. *Zeits. f. ang. Chem.*, **51**, June 27, 1923.—The surface deposit is mostly a thin layer of soda crystals. Soda is dissolved out of the glass by water and combining with CO_2 from the air forms Na_2CO_3. Several microscopic tests verify this assumption. The devitrification of old glass is not due to a change in structure arising from crystallizing forces, but to hydrolysis. In the case of complex glasses he hopes to det. the laws governing soly. which may be attributed to individual oxides. By introducing equi-molecular portions of CaO, SrO, and BaO he found for certain percentages a practically insol. glass was attainable by the use of CaO, while the introduction of SrO and BaO did not attain practical insoly. Further expts. in substituting boric acid for silica were only briefly mentioned. W. M. C.

20. Production of glass wool. ANON. *Le Verre*, **3** [7], 1923; *Keram. Rund.*,

31, 338(1923).—The production of glass wool by means of a machine made by the Duplex Machine Co., Marktrewitz, is described. H. G. S.

21. The why and wherefore of seedy glass during melting. A. J. RITTMAN. *Glass Worker,* **42** [42], 19(1923).—Seeds are suspended gas in the glass and come from the raw mat. Increased ht. or change of batch to lower melting temp. will correct this fault. R. J. M.

22. New glass furnace types in England and Europe. H. W. HESS. *Glass Worker,* **42** [44], 11(1923).—Twelve pot recuperator fur. are being used with success. Greater economy is claimed. R. J. M.

23. Specifications in the British glass industry. W. E. S. TURNER. *Glass Worker,* **42** [45], 11(1923).—From *The Pottery Gaz. and Glass Trade Review.* The need of standard specif. for glass food containers is urged. R. J. M.

24. Treatise on the design of pot arches. T. THEISEN. *Glass Worker,* **42** [47], 11(1923).—Paper before the Brit. Soc. of Glass Tech. Improved types of pot arches to obtain more even heat and higher temp. are discussed. R. J. M.

25. Resistant glass. *Le Verre,* **3,** 183(1923). French pat. 548,253. **Procedure for making a resistant glass.** W. HORAK. March 6, 1922. (Czecho-Slovakia, Feb. 4, 1922).—The chem. compn. in per cent is sand 60–70, boric acid 15–30, potassium carbonate 1–2, sodium carbonate 3–6, kaolin 2–6, mica 0–4, zirconium oxide 1–3, titanic acid (oxide) 1–3, having the following approx. mol. compn. $70SiO_2.20B_2O_3.3RO.-{}^1/_2Al_2O_3.ZrO_2$ (where R = NaK). The glass has a small coeff. of expansion and withstands sudden heating and cooling. (Manufactures of this glass have been given the trade name of "Resista" in Europe.—Abstr.) L. N.

26. The analysis of glasses rich in boric oxide. V. DIMBLEBY AND W. E. S. TURNER. *Jour. Soc. Glass Tech.,* **7** [25], 76(1923).—A method of analysis of sodium boro-silicates of high boric oxide content is described which eliminates errors due to volatilization. J. G. P.

27. The influence of boric oxide on the annealing temperature of boro-silicate glasses. S. ENGLISH AND W. E. S. TURNER. *Jour. Soc. Glass Tech.,* **7** [25], 73(1923).—It is well known that the boro-silicate glasses of which present day chem. glassware is made need a comparatively high temp. for their annealing. Observations point toward boric oxide as the probable cause of the high annealing temp. of commercial boro-silicates. Expts. were conducted on 2 series of sodium boro-silicates, 1 series with 20% Na_2O and variable B_2O_3, the other with 10% Na_2O and variable B_2O_3. The annealing temp. were detd. on samples of rod with plane polished ends as used in previous investigations. The results clearly indicate in the case of the glasses with approx. 20% of Na_2O that as silica is substituted by boric oxide, the annealing temp. rises, reaches a max. at about 16 or 17% of the oxide and then steadily falls. In the case of the glasses with 10% sodium oxide, the values for the glasses examd. fall continuously. J. G. P.

28. A study of the melting and working properties of boric oxide glasses with special reference to the boro-silicates. V. DIMBLEBY, F. W. HODKIN, M. PARKIN, AND W. E. S. TURNER. *Jour. Soc. Glass Tech.,* **7** [25], 57(1923).—Meltings were carried out on 3 series of sodium boro-silicate glasses contg. approx. 20, 10 and 5% sodium oxide. In each series the amt. of sodium oxide was maintained approx. constant while the silica and boric oxide portions were varied. In the first series 9 glasses were prepd. contg. from 0 to 45% boric oxide; in the second series 8 different meltings were made and the amt. of boric oxide ranged from 15 to 50%; in the 3rd series involving 7 meltings the range of boric oxide tested was from 20 to 45%. It was found throughout the range that homogeneous glasses could be prepd. and there was no segregation in layers of different compn. Boric oxide beyond a certain amt. does not make for dura-

bility but the reverse. With increasing boric oxide in each series and diminution in the amt. of silica, the rate at which melting and refining occurred increased rapidly. Soda ash has considerably greater fluxing action than has borax or boric oxide. The rate of change of viscosity increases very greatly as silica is substituted by boric oxide. There was considerable loss of boric oxide through volatilization. All glasses of the 20 and 10% series examd. could be worked readily in a blow pipe and showed no signs of devitrification. J. G. P.

29. The effect of various constituents on the viscosity of glass near its annealing temperature. S. ENGLISH. *Jour. Soc. of Glass Tech.*, **7** [25], 25(1923).—Measurements of the mobility of soda-lime, soda-magnesia and soda-alumina glasses, 1 soda-lead oxide glass and 1 potash-lead oxide glass show that in spite of their variability in working properties, the rate of change of viscosity near their annealing points is almost constant. The mobilities were obtained by measg. the rate at which rods were stretched under the action of a wt. at certain fixed temps. A description of the method and app. is given. The rise of temp. necessary to reduce the viscosity by $^1/_2$ in this range being 8° for 2 glasses, 9° for 10 glasses, 10° for 3 glasses, 11° for 2 glasses and 12° for 1 glass. Twyman's equation is shown to be nearly correct for the range of temp. near the annealing point, especially for the softer glasses. The results indicate that the mobility is approx., but generally not accurately, a logarithmic function of the temp. and that at higher temps. than those used in this investigation the mobility temp. curve for most if not all glasses will have a point of inflection which will to a certain extent det. the sweetness or otherwise of the glasses in their working ranges. Sweetness depends on 2 factors (1) the rate of change of viscosity with temp. and (2) the rate at which ht. is lost by the glass at its working temp. J. G. P.

30. An examination of some current views on the detection of strain in glass. S. ENGLISH. *Jour. Soc. Glass Tech.*, **7** [25], 20(1923).—Strain is not detected in glass by polarized light if the direction in which the stress is acting is parallel to, or at right angles to the plane of polarization of the light incident on the glass. For the best results the glass should be held so that the direction of the stress is at 45° to the plane of polarization of the light. Objections to several marketed strain viewers are made. Strain viewers should be designed so that no light can pass directly from the source to the analyzing nicol and no light from the source can strike the object being tested and be reflected to the eyepiece, otherwise untrustworthy indications are liable to be obtained.
J. G. P.

31. Analysis of bubbles in glass. RESEARCH STAFF OF GEN. ELEC. CO., LONDON (J. W. RYDE AND R. HUDDART). *Proc. Phys. Soc. London*, **35**, 197–8(1923).—In order to distinguish bubbles generated by chem. action in glass from those introduced by mech. processes, spectroscopic tests are made for the presence of N. To liberate the gas from the bubbles, a specimen of the glass is placed in one limb of a quartz U-tube and Hg in the other, and the glass is heated and then disintegrated by sudden cooling, the tube being plunged into cold H_2O at the same time that the Hg is thrown on to the glass. C. C. V. V. (*C. A.*)

32. Some aspects of the autoclave test for durability of glass. W. L. BAILLIE. *J. Soc. Glass Tech.*, **6**, 279–88(1922); cf. *C. A.*, **16**, 2204.—Durability depends not only on the corroding agent employed, but on the method of manuf. and the purpose for which the ware is designed. The use of accelerated tests possibly introduces disturbing factors. The use of glass powder is not recommended, as the surface exposed cannot be estd., there being no simple relation between sieve grading and grain vol. Further, cementation between grains probably occurs when the decompn. becomes extensive and this prevents both free access of the corroding agent to the whole surface and the removal of all the alkali in the final washing stage. The autoclave test executed on finished pieces

of suitable size, or on test blocks cut from finished ware and having the cut surfaces weathered for some time before use, is flexible and capable of producing results in close agreement. Steam is recommended in preference to water as a corroding agent, and times and pressures are conveniently varied to suit the type of glass under test. Thus a series of glasses may be sharply differentiated at 4 atm. pressure, while at 10 atm. all may be equally bad, in which case 4 atm. will be a suitable pressure for the test. Rise of temp. does not accelerate the action of steam on all glasses to the same extent, which may be due to the fact that decompn. is the result of two reactions differently accelerated by temp. rise. The effect of increasing the pressure is not so easily accounted for. It is suggested that high pressures may promote reactions which do not occur at pressures nearer atm. *E. g.*, Turner (*C. A.*, **16**, 4026) found that with glass rich in alkali the alky. at 5 atm. was greater than that at 25 atm. J. S. C. I.

33. Use of the autoclave test as a method of testing glassware. W. H. WITHEY. *J. Soc. Glass Tech.*, **6**, 289–91(1922).—While of very great use for glasses designed for contact with steam or water under pressure, the autoclave test in general is much too severe for ordinary ware. Two glasses alike in their resistance to attack at a low temp. may differ at a higher temp. and the order of their difference may be inverted at a still higher temp.; under the appropriate conditions suited to their characteristics both may be equally good. Tests described on a Zn boro-silicate and a lime boro-silicate glass showed that under prolonged treatment the former flaked, continually exposing a fresh surface to the corroding agent, while the latter acquired a "bloom" through which the corroding agent had to penetrate to reach the glass surface. J. S. C. I.

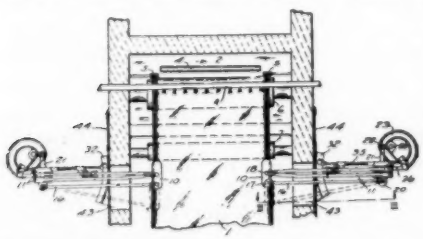
34. Lubrication of glass-making machinery. ANON. *Glass Ind.*, **4**, 130–1(1923). *C. A.*

PATENTS

35. Apparatus for making wire glass. NOAH A. LISTON. U. S. 1,466,025, Aug. 28. An app. for making wire glass, which includes a roll formed of series of annuli or rings mounted on a core, the said rings having serrations, the serrations on one ring being out of horizontal alignment with the serrations on the adjacent ring.

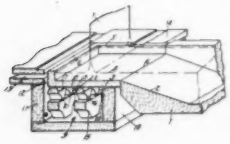
36. Reinforced glass. VICTOR C. EDWARDS. U. S. 1,467,030, Sept. 4. As a new article of manuf., a reinforced glass structure comprising the combination of a transparent sheet of a pyroxylin compn. with a transparent sheet of glass capable of absorbing those actinic rays of light which tend to induce an appreciable color change in said pyroxylin compn.

37. Method and apparatus for drawing and flattening sheet glass. JAMES WHITTEMORE. U. S. 1,466,460, Aug. 28. In an app. for drawing and flattening sheet glass, a receptacle containing a mass of molten glass from which the sheet is drawn upwardly, means for bending the drawn sheet into a horizontal plane, means for reheating and softening the sheet, means for applying the longitudinal draft to the sheet, and means for grasping the edge portions of the softened sheet between the bending device and the drawing means, and stretching the sheet laterally to flatten the same and remove waves and wrinkles.

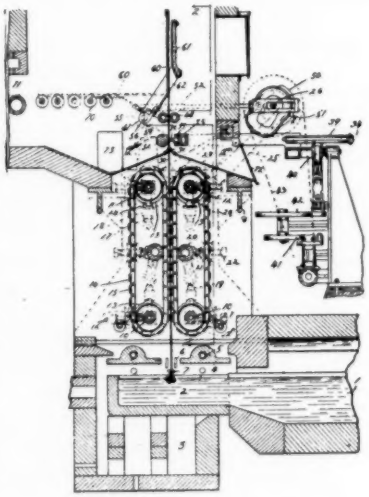


38. Sheet-glass-drawing mechanism. MICHAEL J. OWENS. U. S. 1,466,457, Aug. 28. In a sheet glass drawing machine, in combination with a draw-pot containing

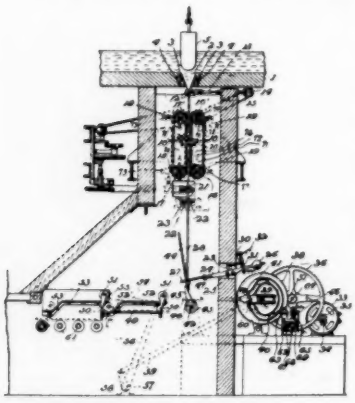
the molten glass from which the sheet is drawn, a transverse supporting member beneath the pot positioned parallel to the line of draw of the sheet, the member having its under side cut away to form a series of open arches, and its upper pot-supporting side beveled at the edges leaving a narrow continuous strip in unbroken contact with the pot.



39. Sheet-glass drawing and delivering mechanism. INGLE B. BUSARD. U. S. 1,466,421, Aug. 28. In an app. for drawing sheet glass, means for drawing a sheet of glass vertically, a horizontal leer conveyor, means for scoring the continuously advancing sheet at spaced intervals, a clamping plate movable against one face of the sheet to break off the section at the score, a supporting frame against which the severed sheet section is clamped by the clamping plate, means for successively moving the clamping plate against the sheet, swinging the plate, sheet section and frame into a horizontal plane, and quickly returning the clamping plate to its vertical position, the carrier frame remaining in horizontal position until it has delivered the sheet section to the leer conveyor, then returning to receive the next sheet section. In combination, means for drawing sheet glass and means for scoring the sheet at right-angles to its length as it is being drawn comprising an endless carrier, a scoring device carried thereby, means for intermittently driving said carrier, and means for guiding said endless carrier obliquely across the face of the moving sheet, the inclination of said guiding means being adjustable to conform to the speed at which the sheet is drawn.

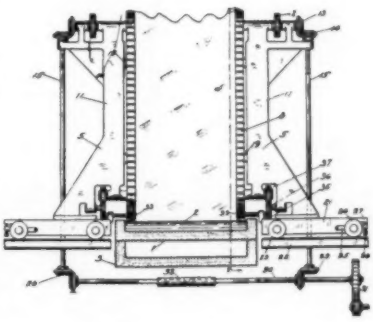


40. Sheet-glass-drawing mechanism. ROBERT P. CALLARD. U. S. 1,469,379, Oct. 2. In a mach. for drawing sheet glass, the combination of a receptacle for molten glass having an oblong slot or opening in the bottom thereof, water-cooled channels arranged on opposite sides of said opening to regulate the temp. of the glass flowing through said slot or opening, width-maintaining means, vertically moving sheet-drawing mechanism drawing the sheet downward, intermittently-operated scoring mechanism for scoring the drawn sheet, and an intermittently-operated carrier for breaking the sheet along the scored line, and a carriage to which the severed section is delivered by said carrier.

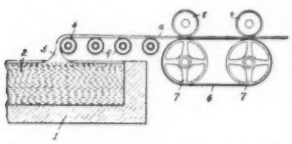


41. Drawing continuous sheet glass. ROBERT P. CALLARD. U. S. 1,469,380, Oct. 2. In combination, means to hold a supply of molten glass from which the glass sheet is formed, a pair of opposed chains at each edge of the sheet for gripping the sheet and continuing in gripping engagement therewith during a predetermined length of

movement of the sheet, and sep. means carrying and guiding the movements of the pairs of chains and adjustable to dispose the sheet gripping flights of the chains parallel to the longitudinal centerline of the sheet or at an angle thereto.

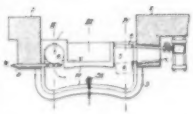


42. Method of and apparatus for producing continuous sheet glass. JOSEPH P. CROWLEY. U. S. 1,469,383, Oct. 2. In a sheet glass producing app., a source of molten glass, a graphite-clay hopper into which the glass flows from the source, there being a slot in the bottom of the hopper through which the glass flows in sheet form, a graphite-clay slab below the hopper, having a concave outer surface for deflecting the sheet into a horizontal plane, and drawing and flattening mechanism for carrying away the sheet.

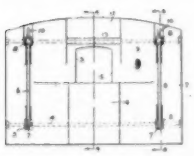


43. Glass-feeding mechanism. EDWARD MILLER. U. S. 1,470,023, Sept. 25. The combination with the discharge spout of a glass tank having an outlet opening of a mold adapted to be located at a lower level than the spout but not in vertical alignment with the opening thereof, means held stationary with relation to the mold for receiving the charge of glass and guiding it to the mold, and means for controlling the movement of the glass from the spout to said glass receiving and guiding means including a member having an opening through which the glass is adapted to flow, a knife for severing the glass, a shear arm mounted below the spout under the discharge opening from the spout, means for reciprocally mounting the knife on the underside of said shear arm in position to sever the glass and temporarily close the bottom of the opening through the shear arm to form a cup for temporarily supporting the unsevered portion of the glass, and means for elevating the shear arm after the glass has been severed.

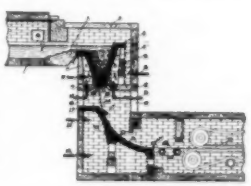
44. Manufacture of glassware. ROBERT GOOD. U. S. 1,469,457, Oct. 2. In app. for making articles of glass, a fur. or tank, a channel for the molten glass communicating at both its ends with the main body of the glass in the furnace, means for causing the molten glass to flow through the channel, the breast of the fur. immediately above the inner edge of said trough being slotted to permit the escape of ht. from within the fur. chamber to maintain the glass in the trough in a highly heated condition.



45. Door for glass-pot furnaces. CHARLES H. CHRISTIE. U. S. 1,469,358, Oct. 2. A fur. door comprising a body portion made up of refrac. mat., longitudinally extending metal rods embedded in said refractory material, said rods being exposed for a portion of their length near the ends thereof, and upright rods on the outside of said door engaging said rods at the exposed portions, and connecting means at the upper ends of said rods for attaching lifting chains.



46. Method of making sheet glass. JOSEPH P. CROWLEY. U. S. 1,469,382, Oct. 2. The method of forming sheet glass consisting in drawing a mass of glass from a molten source, passing the mass laterally while in a highly heated plastic condition over a bend-



ing member and extending it lengthwise to form a sheet before it cools sufficiently to lose its plasticity.

47. Glass manufacture. CORNING GLASS WORKS. Brit. 192,919, Feb. 7, 1922. The colors due to metallic salts in glasses, particularly the borate glasses colored by CoO or NiO, are modified by adding a substance or substances contg. one or more of the halogens. When KCl is added to the batch of glass contg. a very high proportion of boric oxide and colored with CoO, the resultant glass has a green color instead of red. The color change is less noticeable when the proportion of boric oxide in the glass is low or when other halide salts are used instead of the chloride. (*C. A.*)

48. Glass manufacture. V. HORDK. Brit. 112,713, Feb. 5, 1923. A resistance glass is made from a batch contg. 60–70% of SiO_2, 15–30% of boric oxide, 1–2% of K_2CO_3, 3–6% of Na_2CO_3, 2–6% of kaolin, up to 4% of mica, and 1–3% of an oxide of the silicon group, *e. g.*, Zr or Ti. The glass is stated to have a low coeff. of expansion, a high fusing point, and great resist. to chem. action. (*C. A.*)

Heavy Clay Products

49. Highly porous insulating brick. ANON. *Brit. Clayworker*, **32**, 169–70(1923).—Brick having a high porosity are used for insulating purposes for (*a*) in houses, offices and other buildings, in order that a thin wall may be used as effectively as a thick wall for keeping rooms warm in winter and cool in summer; (*b*) as sound absorbers, to insulate rooms which are required to be quiet, from places which are noisy; and (*c*) in fur. and kilns in order that high temps. may be maintained with a minimum fuel consumption. Bricks of the (*a*) and (*b*) types are made of red-burning plastic clay, to which a large propn. (usually an equal volume) of fine hardwood sawdust, seeds, ground lignite, or peat, coal dust, locomotive ashes or other combustible material has been added. For building purposes a highly porous brick measuring 9″ by 4½″, by 2⅝″ ought not to weigh more than 5 lbs. and should have a crushing strength of about 90 tons per sq. ft. Insulating brick for fur. are made by mixing kieselguhr with 10 to 20% clay. Instead of a clay bond, lime may be used as in the manuf. of silica brick. The propn. of lime required for these is usually about 6% while that required for silica brick is only 2%. H. G. S.

50. Sand lime brick. H. D. SEARLES-WOOD. *Brit. Clayworker*, **32**, 22(1923).—A high Ca lime is best for sandlime brick. This should analyze 90–95% CaO with less than 0.5% MgO. The av. crushing strength requirements for different uses are as follows: engineering brick = 2800 lbs. per sq. in.; brick for external walls = 2000 lbs. per sq. in.; and brick for internal walls = 1000 lbs. per sq. in. H. G. S.

51. Building material industries in Czechoslovakia. RUDOLPH BARTA. *Rev. Mat. Constr. Trav. Pub.*, **166**, 162–3(1923).—Czechoslovakia produces annually 2,000 million brick and 200 million tile in 700 large plants; 220,000 short tons of kaolin, 75% being exported to Ger.; 33,000 tons of porcelain in 70 plants, 70% being exported mainly to the Balkans and the U. S.; 440,000 tons of refractory brick; 22,000 tons of faience; 60,500 tons of common and chemical stoneware; 99,000 tons of slabs; 550,000 tons of Portland cement; 990,000 tons of lime. L. N.

52. Kieselguhr mining. ANON. *Oil & Colour Trades Jour.*, **54**, 823(1923).—A company has recently been formed in Sweden for the exploitation, for use as a building mat., of the large deposits of kieselguhr in the polder of the former lake of Jallasjo, near Vanas Sag, in the Province of Kristianstad. This deposit differs from all others in that there is a natural intermixture of about 20% bituminous products, which form an excellent binding material. O. P. R. O.

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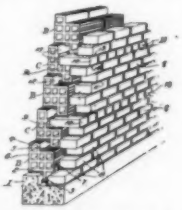
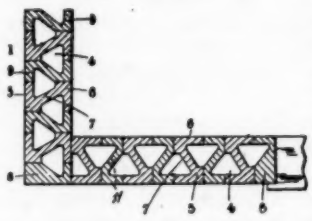
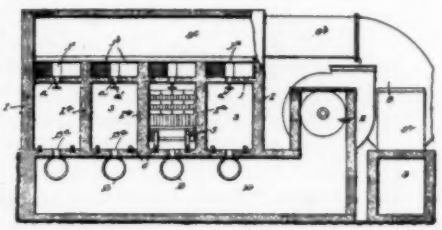
53. Hollow-tile wall construction. RICHARD S. REQUA. U. S. 1,467,117, Sept. 4. A wall structure of brick facing having a header course and hollow-tile backing, the tile being of substantially Z form with the tile opposite the header course of brick broken away to receive the header brick, the tile above such header brick being of normal form and resting directly upon such header brick.



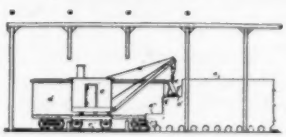


54. Building brick, block, and the like. JOHN VER MEHR. U. S. 1,468,892, Sept. 25. A structure composed of blocks of substantially Z or S shape in plan, arranged in courses one above the other the blocks in a course being assembled or arranged alternately in Z and S formation each alternate block being of less width than the adjacent blocks and constituting a header block.

55. Apparatus for drying brick and other clay articles. JOHN C. BOSS. U. S. 1,468,990, Sept. 25. Apparatus for drying brick and other clay products comprising a series of closed tunnels arranged side by side and having means for admitting loaded cars thereto, conduits above and beneath said tunnels, and communicating therewith, a transverse flue located above the upper conduits and communicating therewith, a blower for supplying heated air under pressure to said transverse flue, a second transverse flue beneath the tunnels communicating with all of said lower conduits, and a suction fan for exhausting air from said second transverse flue.



56. Method of and means for handling and hacking bricks. FRED S. WALLACE. U. S. 1,469,200, Sept. 25. The method of hacking bricks, which consists in assembling in a conveyor at the kiln a complete vertical tier of such bricks the full width of the coöperating carrier, moving the conveyor and contained bricks to said carrier, and placing said tier of bricks as a whole upon the carrier, substantially as set forth. A conveyor for hacking bricks, comprising a wheeled truck, a support for a separate bottom row of bricks, means for withdrawing said support, and a plurality of stationary arms adapted to sustain a vertical tier of bricks, substantially as set forth.



Refractories

57. Magnesite production in Austria. ANON. *Brit. Clayworker*, **32**, 174(1923).—The Austria-American Magnesite Co.'s works at Radentheim in Carinthia. The deposit lies on a plateau at an altitude of 1700 m. From here magnesite is transported by aerial cable 9 km. long. Grading and selecting is unnecessary. It is calcined at 1600–1700°C. One of the rotary kilns is 50 m. long and has a diam. of 1.8 m., its output being 55 T. of calcined magnesite in 24 hrs. Another kiln is 100 m. long and has a diam. of 2.85 m., its output being 200 T. per day. The coal consumption is 30 to 40%

of the output tonnage and is introduced in the pulverized form. The calcined product analyzes between the following limits: MgO = 85–88%, CaO = 1.5–2.5%, Fe_2O_3 = 4–5%, Al_2O_3 = 1–5%, SiO_2 = 4–6%. As the fumes are injurious to vegetation the spent gases are carefully purified before being released into the air. Attached to the works is a brick plant where calcined magnesite is mixed with 5–7% water and pressed in to brick with a press. of 1000 kg. per sq. cm. They are then fired at 1500–1520° C in a fur. tunnel through which they are passed. H. G. S.

58. A new refractory material. W. SMITH. *Tonind.-Ztg.*, **47,** 530(1923).—Clay is impregnated with C by heating it together with coal at low temps. The clay thus treated may be bonded with tar and the products made in this manner are fired before using. It is claimed that this will make an excellent refractory being very resistant to slag action. H. G. S.

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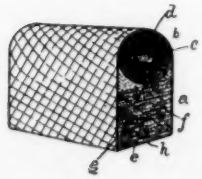
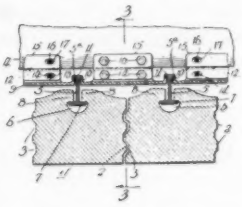
59. Refractory furnace linings. E. CONE and J. W. HALE. Eng. pat. 199,144, March 17, 1922. The inner lining of the fur. is constructed of a wall, one brick thick and the space between it and the outer wall filled with a rammed-in plastic mass of the compn.; graphite 50, fireclay 25, silica rock 5, magnesite 5, anhydrous gas tar sufficient to render plastic. Alternatively the plastic mass may extend with the brickwork in layers to the inner surface of the furnace. The method is applicable to basic, neutral, or acid refrac. mats. (*Jour. Soc. Chem. Ind.*) O. P. R. O.



60. Packing for pistons. THEODORE A. MEYERS. U. S. 1,467,113, Sept. 4. An expansible packing embodying a resilient section provided with a tubular rubber core, a pair of parallel fabric body triangular sections, and a jacket for assembling said sections as a unit.

61. Firearch. HERMAN A. POPPENHUSEN and ARTHUR P. STRONG. U. S. 1,466,751, Sept. 4. A firearch, comprising an upper structure, a plurality of contacting tiles arranged in rows beneath the same. I-beams engaged with said tiles and projecting above the same, plates extending between and engaged with said I-beams above said tiles for suspending the I-beams from said plates, said plates extending over the joints between said tiles for preventing the downward passage of air between said tiles, means for preventing the passage of air between said plates and I-beams, and means for suspending said plates from said upper structure.



62. Graphite crucible. KOZO NAKAMURA. U. S. 1,466,739, Sept. 4. A crucible having the side walls thereof constructed of a plurality of superimposed substantially V-shaped layers of graphite.

Whiteware

63. Symposium on casting. *Ceramist*, Spring Quarter, 6–27(1923).—ANDREW FOLTZ describes an arrangement for prepg. casting slip and distributing it throughout the shops by means of compressed air. ERIC TURNER:—Cast saggers cost slightly more than machine or hand made, but they carry a load better. This is attributed to a denser structure which is not disturbed by subsequent repressing. Cast slabs used as targets in oil-fired fur. have the advantages of dense structure and also a thin, but dense surface skin. The grog slip is prepd. in much the same manner as whiteware

slip, excepting that the body is not filter pressed. A mixt. which has given satisfactory service (for saggers?) in general ware and sanitary kilns is as follows:

	Per cent
No. 1 fire clay	25
Plastic fire clay	25
1/4-in. grog	25
1/8-in. grog	25
Water glass	.25 of 1%
Sodium carbonate (crys.)	.20 of 1%

The larger plaster molds used for casting grog bodies should be reinforced on the outside with wood or metal. Wares with max. thickness of $1–1\frac{1}{2}''$ can be cast in the same mold every 6 hrs., while pieces 4 or 5″ thick require 16 to 24 hrs. in the mold. The continuous circulation of hot air around the outside of the mold facilitates the casting operation. 30 slabs measuring 4′ x 3′ x 4′ $\frac{1}{2}''$ were cast out of the same mold in as many days. LESLIE BROWN:—For use in the casting of hollow tableware and for a combination of cast and jiggered tableware the materials are first carefully air dried. The body is ground in a ball mill for a definite number of evolutions; the electrolyte is then added and the grinding continued for one hour. The slip is forced by air pressure from the mill through a fine bronze lawn of 200-mesh, passed over electromagnets into agitators and then forced by pumps through galvanized iron pipes for a distance of 500 ft. on the ground floor and then to the 3rd floor of the building where it is used. The dried scrap is weighed, blunged with the necessary amt. of water to which has been added the electrolyte. In ball mill grinding, the wt. of the flint pebbles should be checked very accurately. The actual loss by wt. of a total of 2900 lbs. of pebbles has been found to be 56 lbs. at the end of a 6-day grind. In other instances, the loss averaged 12 lbs. T. A. KLINEFELTER:—The formation of balls or kernels in the ware in casting high tension elec. porcelain is experienced in pieces having a thickness greater than 1″. The use of ht. under the molds to keep them thoroughly dried out during casting was found to be of some assistance in making thick ware. TAINE MCDOUGAL suggested the practice of using a certain propn. of the porcelain body in a calcined ground condition which is being done in the spark plug industry. 45–50% of the body is being calcined to pass 120-mesh. F. W. DINSMORE:—Pieces of elec. porcelain ware 2″ and $2\frac{1}{2}''$ thick are being successfully cast with practically no loss through cracking. These pieces measure from 25″ to 26″ long and $7\frac{1}{2}''$ to 8″ in diameter with corrugations the full length. R. H. MINTON:—Molds used in Germany for casting are constructed with thin walls reinforced with outside straps of iron. C. W. P.

64. The burning of porcelain with fuel oil. A. GRANGER. *Chimie et industrie*, **Special No.,** 330–2(May, 1923).—Operations at the Royal Copenhagen Porcelain Works and at Sèvres have shown that fuel oil can be successfully used and is much more flexible than coal or wood. A. P.-C. (*C. A.*)

65. The re-circulation drier uses little power. H. H. HALLATT. Can. Natl. Clay Prod. Assn., *20th Annual Rept.*, **16**(1922).—The power to operate this drier of nine re-circulating fans, designed by H. of the Tilsbury Brick and Tile Co. (Ontario, Can.), is actually less than 1 h. p. The drier itself is of brick, concrete and steel construction; its capacity is easily a 24-ft. kiln full, or approx. 20,000 4-in. tile per day. H. claims that capacity output on 5 by 8 by 12 in. bldg. tile has been handled by this drier, with practically no waste, and these blocks are the hardest pieces they have. The drier is a 6 track re-circulating waste heat drier and is 63 ft. long and 28 ft. wide. 74 drier cars are used. The drier itself holds 54 cars at one time, 2 shoves are made during the night; the cars are pushed by one man through this short drier without the use of a jacking

app. Re-circulation of drying air is a necessity if the best results are to be obtained. The drying air passing horizontally along the side and top of a tunnel makes the drying of tender clays made into hollow wares and drain tile practically impossible without excessive cracking. By re-circulating the drying air, thus breaking up the hot and cold currents and by forcing the air either up or down through the hollow ware standing on end on the cars, ideal control of the drying and complete saturation of the drying air is possible, which makes possible drying with the utmost economy. This drier is equipped with 9 Ventura fans (48 in.) and 2 exhaust fans. 5 h. p. is actually required to operate all the fans, although the drier motors used have a combined capacity of the 11 h. p. The fans are so arranged that 1 motor or engine would be sufficient. Illus. O. P. R. O.

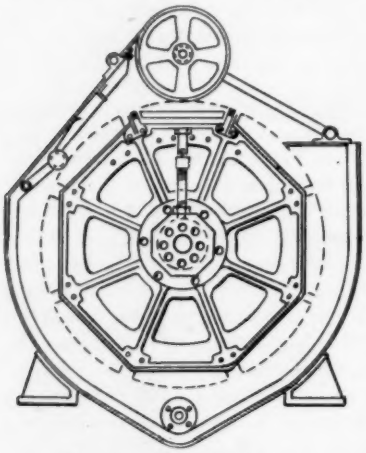


FIG. 1.—Filtering drum.

66. A continuous filter press for ceramic slips. ALIX. CORNILLE. *Rev. Mat. Constr. Trav. Pub.*, **166,** 123–7B(1923). (English translation in *Chem. Age* (London), Supplement, **9,** 9–10(1923). Abstr.)—Description of the Hertenbein continuous filter press (with 7 figures). In a horizontal semi-cylindrical vat, contg. the slip, the filtering drum having an octagonal cross-section is made to rotate about its horizontal axis. Eight boxes having flat bottoms and cylindrical tops are attached to the drum, forming a complete outer cylindrical surface. Each curved segment is perforated and covered with a filter cloth, that is easily replaceable. Two holes in the bottom of each box allow compressed air through one and suction through the other to be applied to the filter cloth. The suction pipe lines lead to the shaft of the filtering drum through one end to a pump, while the compressed air lines lead to the other end of the shaft into a reservoir and then back to the same pump. As a box enters the slip in the vat the openings in the suction line are engaged so as to cause a partial suction in the box, thereby drawing the water through the filter cloth and leaving the concd. ceramic paste on the surface of the cloth, for a rotation of 245 degrees of arc. On leaving the slip the filter cloth with its layer of paste is dried by further suction through 45° of arc. The cycle is completed by having the paste removed by a counterpoised roller touching the filter cloth, with the help of the compressed air which is automatically directed against the filter cloth from the underside. The paste is removed from the roller by a scraper. The box with its filter cloth then again enters the slip. With all 8 filter cloths in position the drum works with $^{11}/_{16}$ of its surface immersed in the slip. Provisions are made for removing the excess water collected, and for regulating the air pressure. A small model with a 12-in. diameter drum was capable of treating 330 lbs. of kaolin per hour. L. N.

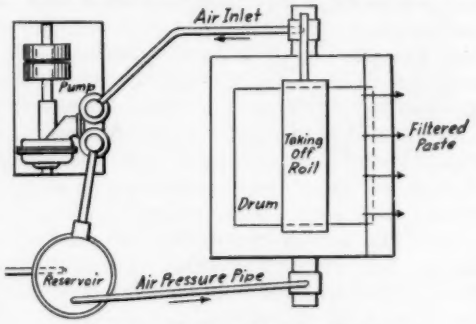


FIG. 2.—Filter with accessories.

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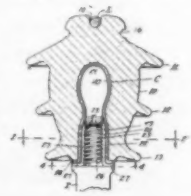
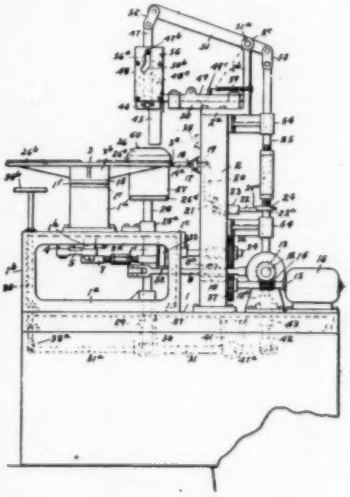
67. Line insulator. LOUIS STEINBERGER. U. S. 1,468,044, Sept. 18. An insulator having a hollow metallic thimble secured thereto and forming a chamber therein, said thimble being provided with an expanded upper portion and longitudinal ribs on its lower portion, said thimble being provided with screw threads and a protecting flange, the inside of said ribs being provided with grooves to form passageways to permit of communication between the interior chamber of said thimble and the atm. when said insulator is mounted upon a supporting pin.

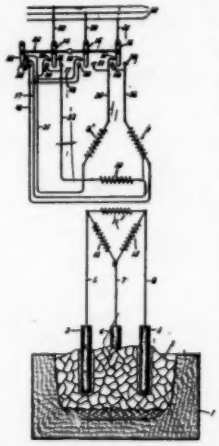


68. Furnace for decorating ceramic ware. JOSEPH A. JEFFERY. U. S. 1,468,947, Sept. 25. In a fur. for progressively heating bodies, a metallic tubular member in which the bodies are placed, a means for heating the tubular member, a porcelaineous lining located in the tubular member for protecting the bodies and the walls of the tubular member.

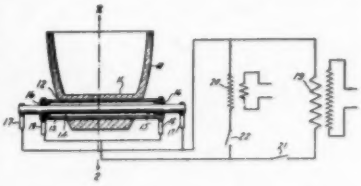
69. Pottery-forming machine. MARTIN BURGER. U. S. 1,469,378, Oct. 2. In a mach. for shaping plastic mat., a support, a plunger, a former tool carried by said plunger, means for actuating said plunger, and means for guiding and moving said plunger and former tool laterally while being actuated by said plunger actuating mechanism.



70. Electric furnace apparatus and method of operating the same. JOHN A. SEEDE. U. S. 1,466,603, Aug. 28. The method of operg. an elec. arc fur. supplied with alternating current which consists in first operg. the fur. with a short arc, thereupon increasing the length of arc while maintaining the current value, and finally reducing the length of arc to operate with a lower energy input.



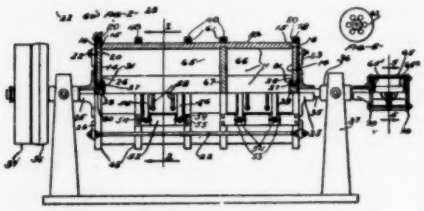
71. Electric furnace. EDWIN F. KIEFER. U. S. 1,467,044, Sept. 4. An elec. fur. of the arc type, comprising a refrac. wall provided with an aperture, and a htg. element insertable in such aperture, said htg. element comprising electrodes in arcing reln. to each other in a closed interspace therebetween.



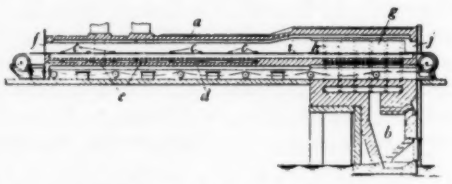
72. Method of and apparatus for drying and conditioning materials. WILLIS H. CARRIER. U. S. 1,467,306, Sept. 11. The herein described method of drying mat. which consists in circulating a body of air through the mat. in a drying chamber, supplying to and mixing with

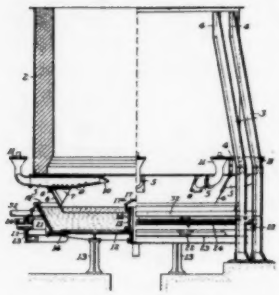
said circulating body of air a relatively much smaller vol. of air, maintaining a predetd. wet bulb temp. of said smaller vol. of supplied air previous to its supply to the chamber by mixing fresh air and return air from the drying chamber and regulating its humidity under the control of the wet bulb.

73. Pulverizing mill. FRANKLIN H. WOLEVER. U. S. 1,468,893, Sept. 25. A mill for pulverizing enamel stock and the like comprising a rotative barrel formed with end walls and a circumferential wall of internal polygonal cross-section, with the segments meeting at angles of from 90 to 135°, all made of vitreous porcelain, the circumferential wall being continuous from end to end and joined to the end wall by internal dry joints, said circumferential wall being made of solid vitreous porcelain staves and being joined along integral beveled edges by internal dry joints to produce the angle specified and means exterior to the internal faces of the joints between the beveled edges of said staves and between the end walls to hold the barrel members rigidly together.



74. Furnace. THEODOR TEISEN. U. S. 1,469,461, Oct. 2. In fur. kilns or leers, the combination comprising a long horizontal cooling chamber through which are conveyed the articles to be treated, a collecting flue located beneath the floor of the chamber, a plurality of passages arranged at intervals in the side walls of the said chamber with their inlet ends at a distance above the floor of the chamber and located between the chamber and collecting flue, and a branch outlet flue for discharging hot gases from the collecting flue, substantially as described.





75. Gas producer. FRANCIS H. TREAT. U. S. 1,469,399, Oct. 2. In a gas producer, a stationary ash pan, a trough surrounding said ash pan, and means for elevating ashes over the peripheral edge of said ash pan and delivering the same to said trough, substantially as described.

Geology

76. Kaolin. ANON. Rept. on Mining Operations in the Province of Quebec during the Year 1922. p. 81–90.—After a period of quiescence, work has been resumed on the china clay deposits of Amherst township and has been pushed actively throughout the year of 1922. The shipments of kaolin during that year amounted to 1296 T. valued at $18,532, of which 1196 tons were washed white china clay, and 100 T. were stained kaolin used as fire clay. The report also contains a summary of the history of these kaolin deposits dealing with origin, distribution, character, composition and development.

O. P. R. O.

77. China clay deposits in Malay. W. R. JONES. *Chem. Age, China Clay Trade Rev.*, Sec. v, **9**, 16 (1923).—Extensive china clay deposits were recently discovered not far from the famous tin mining center of Ipoh, Malay. Exhaustive investigations were immediately carried out to ascertain the exact amt. of raw mat. available before

a pottery was started. These were found to be enormous and the manuf. of pottery has now passed the exptl. stage. O. P. R. O.

Chemistry and Physics

78. The estimation of hydrogen in producer gas. WILHELM. *Feuerungstechnik*, **11,** 171–2(1923).—An indicating and recording device for the continuous detn. of H_2 in producer gas is described. It depends on the very high heat cond. of H_2 compared to the other constituents, which have nearly equal conds. Two fine Pt wires are stretched axially in holes bored in a metal block. The sample of producer gas, cleaned and freed from H_2S by $CuSO_4$, is passed through one hole; air is sealed in the other. A fixed heating current is passed through the two wires, which form two arms of a bridge. A galvanometer gives readings in % H_2 directly. The zero point of the instrument is set to allow for the known effect of CO_2 and CH_4. The instrument is in successful operation, the accuracy being better than 0.5%. ERNEST W. THIELE

79. Analysis of silicates. RUDOLPH BARTA. *Rev. Mat. Constr. Trav. Pub.*, **166,** 156(1923).—In analyzing silicates, decomposable by acids, especially cements, it has been found difficult to filter and separate the silicic acid. Jaroslav Mateyka has traced it to the influence of the chloride $SiCl_2$, $CaCl_2$, in the presence of meta titanic acid. This may be remedied by the addition of ammonium chloride. L. N.

80. The problem of the combination of water in zeolites. O. WEIGEL. *Centr. Min. Geol.*, **1922,** 164–78, 201–8; *Chem. Zentr.*, **1922,** III, 702–3.—The close agreement of the exptl. results of W. (cf. *Sitzungsber. Ges. Beförderung gesamten Naturwiss. Marburg*, **1919,** no. 5; *Chem. Zentr.*, **1920,** I, 242) with those of Scheumann (cf. *C. A.*, **15,** 3804) is emphasized, but it is not considered that the break in the dehydration curve at the 0.5 mol. value for the heulandite reported by Scheumann is exptly. verified. Both investigations show that heulandite contains no H_2O combined such as that in ordinary hydrated salts, but at the best is a special kind of solid soln. which as a result of the directing forces of the relatively rigid silicate lattice on the easily mobile H_2O component shows an analogy to true hydrates. Contrary to Beutell (cf. *C. A.*, **17,** 515) it is maintained that (1) the practically complete reversibility of hydration and dehydration at temps. below 180° are proved exptly. and also that Scheumann has shown that (1) no permanent change is caused by dehydration up to a H_2O content of 3 mols.; (2) contrary to Beutell the curve at low temps. shows almost complete continuity; (3) the breaks in the curve would not appear at higher temps. with integral mols. if any considerable decompn. actually occurred; (4) the curves of Scheumann and W. conform to one another closely up to 200° though the preliminary treatment of the material was different in each case; (5) no evidence was found by optical expts. of decompn.; and (6) Stoklossa observed by optical means no decompn. of the mol. when dehydrated to 2.5% H_2O. Beutell has not proved his assertion that zeolites contain H_2O combined in a manner similar to hydrated salts. C. C. D. (*C. A.*)

81. Colloidal clay. D. CASIMIRO BURGUÉS Y ESCUDER. *Mem. acad. cienc. artes*, **17,** No. 19, 18 pp.(1922).—Ten-g. portions of air-dried, 1 mm.-mesh clay were shaken with 200 cc. 1:1000 soln. of different dyes, and the amt. of unadsorbed dye remaining in each soln. was detd. colorimetrically. Following is the vol. of 1:1000 dye soln. which, if dild. to 50 cc., would match the color of the soln. of unadsorbed dye: "Crystal violet O," 4 cc.; "concd. acid green," 10 cc.; "dianiline red," 10 cc. "Methylene blue DBB" was almost completely adsorbed, and "fuchsin in large crystals" even more so. If 5-g. portions of clay were used, 7 cc. and 2 cc., resp., of methylene blue and fuchsin, when dild. to 50 cc., matched the colors of the unadsorbed dyes. The presence of $CaCO_3$ in the clay did not alter its power to adsorb methylene blue. Other expts., not detailed, indicate that the amt. of dye adsorbed by a clay is not a satisfactory quant. measure of

the colloidal matter in the clay, because other components of the clay may also adsorb dye. This paper is largely a résumé of the work of others. R. H. I. (*C. A.*)

PATENTS

82. Decomposition by acids of siliceous alumina compounds. AKTIESELSKAPET HOYANGFALDENE, NORSK ALUMINIUM CO. Norw. 35,193, July 3, 1922. Clay is treated with H_2SO_4 in a rotary drum coated with acid-resisting material. The acid is applied dropwise in amts. somewhat insufficient for complete decompn. Practice shows that Al_2O_3 is still completely liberated. Heat is produced by the reaction. Accordingly the mass is passed through a heated drum where the temp. is kept above 140° but not so high that decompn. of Al sulfate takes place. By the following extn. Al sulfate (and Fe sulfate) is obtained in the soln. and the remaining undissolved SiO_2 is easy to filter.

General

83. Stain and efflorescence on ceramic products. F. BIGOT. *Rev. Mat. Constr. Trav. Pub.*, **166,** 121–2B(1923).—*Green stain or efflorescence* has been noted to appear on clay bodies heavily charged with mica. A kieselguhr contg. a notable quantity of manganese showed a similar efflorescence on exposure to humidity. A stoneware clay to which had been added 2–3% chromite and burned to 1200° in an oxidizing fire, developed a green efflorescence on exposure to dampness. Calcareous white bodies used for faience, covered with a heavy lead glaze, often show a yellow coloration in the glaze characteristic of lead and chromium—such colorations not being observed in opaque tin glazes. Green stains are produced on clays contg. alkalies, the alk. earths even in large proportions not preventing the formation of sol. salts. Firing with coal containing sulphur seems to aid the formation of such stains. *Lead glazes vs. leadless glazes.* In the manuf. of faience tableware, a yellow stain is often prominent on large pieces requiring time for drying after dipping in a lead glaze, the pieces most often being worthless after firing. However with a leadless, boric acid glaze, no colorations are noticeable. The industry has the choice of eliminating the undesirable colorations by (1) biscuiting the body to a temp. high enough to dissociate completely the complex compds. of lime, silica, carbonic and sulphuric acids (about 1000°), and then using a lead glaze, or (2) by using leadless glazes (boric acid) instead, with the usual biscuit burn. *Grey colorations.* A dull grey coloration visible through a transparent glaze was traced to the presence of calcium sulphide contained in the plaster of Paris used as a mold. The impurity was introduced by the reduction of the gypsum in the hot part of the kettle fired with lignite which gives a long flame. Exposing the clay products having the grey coloration to sunlight restores them to their original whiteness in a few days, whereas exposing them in a humid unlighted place required many months for the same result. L. N.

84. The use of fuel oil in the clay industry. ANON. *Brit. Clayworker*, **32,** 166–8 (1923).—Fuel oil is a well defined product of the distillation of petroleum the lighter oils having been removed. This viscous oil has certain well defined phys. and chem. properties. At 60°F the sp. gr. = 0.95; the flash point is above 150°F; the S in it is about 3.5%; the calorific value is about 18,750 B.t.u. Its flame temp. is high and is above that required in any operation connected with clay working. Hitherto, brick burning with oil has not been successful and has not been studied technically in a systematic way. The reason for this is that the types of burners used until recently have not proved satisfactory. Further expts. in the use of oil for burning brick may be successful. For drying china clay it has recently been found very satisfactory. The cost of drying clay was reduced in one case from 8s. 6d. to 7s. 9d. per ton of clay by using oil firing instead of coal. H. G. S.

85. Saving coal in ceramic plants. BASCHANT. *Deut. Töp. Zieg. Ztg.*, **54**, 239–40, 247–48(1923).—In firing boilers the grate area should be ample so that rushing the fire will be unnecessary. If the grate bars are set high the fresh air will prevent the bars from becoming overheated. Coals producing a large amt. of soot should be avoided since the soot becomes caked on the pipe acting as an insulator. In some cases it is more economical to use coals with a low B.t.u. value. With boilers in which a low temp. must be maintained coals having a low B.t.u. value are most economical and produce a more uniform ht. A boiler scale 1 mm. thick will increase the fuel consumption 5%. To distil impure water, the hot steam may be led through tanks and thus preheat this water. When possible soft water should be employed for boilers. After installing a water purifying equipment in a plant it was not necessary to clean the boilers so often. This equipment consisted of one 3 m. high cylinder and one 1 m. high. The water was pumped into the 1 m. cylinder through a sand filter into the 3 m. cylinder then heated to 50–60°C by means of exhaust steam coils, which caused the sediment to settle. For well water the amt. of $CaCO_3$ and $CaSO_4.2H_2O$ should be detd. and the corresponding amt. of Na_2CO_3 or scale preventor should be added. When using impure water it is good practice to fill up the boiler above the water line every night. Before firing the boiler the next morning, drain the boiler to the water line and it will be found that a large amt. of sediment will be removed. If the plant is shut down in the fall, clean the boilers by applying a mixt. of 3 parts wood tar and 1 part graphite to the interior of the pipe and remove by means of a boiler brush. A common mistake is to fire boilers to produce a min. pressure. A boiler producing a pressure of 10 atmos. requires a temp. of 183.1°C and consumes 667.1 cal. of ht. The same boiler operated at 6 atmos. requires 164.6°C and consumes 662 cal. About 62.95% coal is actually utilized in htg. up the water, 22.1% is lost in waste gases, 7.47% is lost in unburned coal in the ashes and in cinders and 7.57% is lost by conduction. H. G. S.

86. Ceramic ware for machines. F. SINGER. *Zeit. Verein. Deut. Ingenieure*, **24** (1923); *Tonind. Ztg.*, **47**, 537(1923).—S. calls attention to the fact that certain ceramic products can be used to replace many cast iron parts on machines now being used in the shops of various manuf. plants. H. G. S.

87. Ceramic work. W. G. WORCESTER. Can. Natl. Clay Prod. Assn., *20th Ann. Rept.*, **7** (1922).—Ceram. work has been undertaken by the Sask. Govt., because it has long been recognized that the province is preëminent as to its raw mat. for the production of brick and pottery. A dept. of ceram. has been established in the University of Sask., with a very complete ceram. lab. for the testing of all grades of clay. A Clay Products Intelligence Bureau has been formed, and Sask. brick, tile, pottery and raw clay have been exhibited at her largest cities. A careful and systematic survey of the more outstanding undeveloped clay deposits is under way. Up to the present there have been tested fire clays, china clays, including the ball and stoneware clays, terra-cotta clays, paving brick, buff and red face brick clays, numerous clays for the manuf. of the more common lines of clay products and clay for paint and paper manuf. O. P. R. O.

88. Education—old style. EDITORIAL. *Nat. Resources*, **1** [1], 2(1923).—Importance is emphasized of recent expts. by the U. S. Bur. Mines in coöperation with the Central of Ga. Ry. in the ceram. interests of Ga. ED.

89. The lime, cement, ceramic and glass laboratory of the Conservatoire National des Arts et Métiers, Paris. ANON. *Recherches et inventions*, **4**, 690–6(1923).—Description of the equipment. A. P.-C. (*C. A.*)

PATENTS

90. Heat-insulating material and method of manufacture. OSCAR GERLACH. U. S. 1,468,149, Sept. 18. A method of preparing a ht. insulating compn. including

adding a sol. metallic salt to a soln. of a silicate, sepg. the gelatinous ppt. so formed from the salts in soln., and mixing the sepd. ppt. while it is still moist with infusorial earth.

91. Elutriation of clay and kaolin. B. SCHWERIN. Can. 233,737, Aug. 21, 1923. The clay is put into suspension and brought to the sol. condition by the addition of a suitable electrolyte, it is then allowed to settle. (*C. A.*)

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Ceramic Abstracts

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Of Sanitary and Electrical Porcelain

Recent investigations have shown that the blistering of vitreous white wares has invariably been due directly or indirectly to OVERFIRE or SOLUBLE SALTS.

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American Ceramic Society

A Monthly Publication Devoted to Proceedings
of the Society, Discussions of Plant Problems, Discussions
of Technical and Scientific Questions and
Promotion of Coöperative Research

Edited by the Secretary of the Society Assisted by Officers of the Industrial Divisions

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EDITORIAL

SCIENTIFIC RESEARCH ENTERS NEW ERA

On page 150, *Bulletin* section of the June issue of this *Journal*, appeared these paragraphs.

> Scientific research, affording new channels for the aspirations of the engineer, is entering upon a new era both here and abroad. Following the $500,000 gift of Ambrose Swasey of Cleveland, making possible the organization of Enginering Foundation, comes news from London that Sir Alfred Yarrow has given the same amount to the Royal Society for the same purpose.
>
> The philanthropy of Sir Alfred, who is an honorary member of the American Society of Mechanical Engineers, is characterized as another step toward the identity of effort which engineers and men of science are striving to accomplish throughout the Anglo-Saxon world. "I should like to record my firm conviction that a patriotic citizen cannot give money, or leave it at his death, to better advantage than towards the development of science, upon which the industrial success of the country so largely depends," said Sir Alfred in his deed of gift.

Since then other large endowments have been made for industrial research. The American Chemical Society has an annuity of $25,000 to be given as prize for the most valuable contribution to the knowledge of chemistry or chemical processes. The National Research Council has a

long list of endowments and research funds. The number of manufacturing concerns having a well equipped laboratory and well trained research force is increasing. All the technical associations and societies have rapidly growing rosters and are engaged to a continually increasing extent in the promotion of scientific education and industrial research. The record of membership increase in the AMERICAN CERAMIC SOCIETY, as here shown, typifies an increasing realization on part of the ceramic industrialists of the value of technical application of scientific research which is paralleled in nearly all industrial lines.

	1922 12 months			1923 11 months		
	Personal	Corporation	Total	Personal	Corporation	Total
New Members Secured	359	84	443	392	73	465
Losses	98	7	105	73	5	78
Net Increase	261	77	338	319	68	387
Roster Total	1611	216	1827	1930	284	2214

It is not due altogether to the effort of the membership committee nor altogether to the substantial value there is in the accomplishments of the SOCIETY that during the past eleven months the SOCIETY has added a larger number to its roster and at the same time had a smaller number of withdrawals than during the previous twelve months. To no small degree these data reflect an increasing appreciation by ceramic executives and plant operators of the necessity of keeping in touch and abreast with the rapidly accumulating amount of fundamental facts and principles and of their industrial application.

The ceramic industries find it profitable to support collegiate schools and the federal and state research departments. They find profit in the trade press and the technical literature. But there is no means whereby the information from and through these several sources can be applied except by the plant operators. The plant operators must obtain, understand and apply the information.

The program of service on which the AMERICAN CERAMIC SOCIETY is engaged is to stimulate research, to analyze facts and methods, standardize materials and products, publish results of original investigations, abstract the world's literature, publish bibliographies, and by every other practical means to make available to the operators of ceramic factories all the information most pertinent to manufacturing the highest quality of wares most economically. This is an extension educational work that is imperative to solid welfare of the ceramic industries.

It is in support of this sort of service that large donations and endowments are being made, for which large organizations are supported and for which many concerns maintain extensive laboratories. It is because of the value in such services that nearly all trade associations in all industrial lines are supporting technical research.

It has been proven that when the manufacturing concerns generally, large and small, are coöperating in working out their common fundamental problems that larger benefits accrue and these more promptly.

The work being done through the channels provided by the AMERICAN CERAMIC SOCIETY will be more effective and the returns larger in proportion to the number of plant executives and operators on its roster. This being a mutual SOCIETY in which all have equal responsibilities and benefits there is every reason for enlisting the largest possible number of ceramic workers. It increases the number of contacts through which information is obtained and applied. For this reason the membership committee is vigorously working to increase the number of co-laborers. And because the services rendered through the SOCIETY results in more economical plant practices and better quality of wares the corporations are being asked to help make possible the rendering of this service to and through their plant operators at the smallest possible cost to the operators. This opportunity must be kept within the financial means of the young men in the plants.

PAPERS AND DISCUSSIONS

OBSERVATIONS ON THE EUROPEAN GLASS INDUSTRY[1]

By Henry W. Hess

The conditions of the European glass industry are undergoing rapid changes, in keeping with all other events of these countries. During the last few years, especially last year, the production of German glassware was made on a very cheap basis, and practically stopped English manufacture. In several cases, the jobbers of glassware were themselves stockholders in English companies, and they found it more profitable to discontinue manufacture, and to handle German goods. Of late, this condition has changed somewhat, as German costs are rising, and it has given the English manufacturer a chance to develop his own business. As a result, there is more activity in English glass circles.

In America, the labor problem, and other economic conditions, together with our national custom of large mechanical installations, have developed the production of much machine-made goods. In European countries where labor has been cheap, and at the present time capital for investment is scarce, there has been until recently a slow-down of machine development in the glass industry. Even with this condition existing, the invasion of Europe with American glass machines has started and its march is certain.

The Libbey-Owens Sheet Glass Company has established a plant at Moll near Antwerp, in Belgium, with offices at Brussels. The Company is known as the Compagnie-Internationale pour la Fabrication Mecanique des Vers. This is a most modern plant with by-product coke ovens owned by the same company supplying fuel. The plant will consist of three furnaces and six machines. This glass will be used all over Europe, as Belgium exports, even now, over 90% of its glass products.

In this connection, showing the trend of the times, it is interesting to note that the hand producing window glass companies are financially interested in the mechanical plants. In Spain the new window glass plant near Barcelona, operating two machines, will be of the Libbey-Owens type. In Switzerland, the same type of machine plant, using one machine, is being built.

The O'Neill machine, also built and developed at Toledo, Ohio, with branch plant at London, has over one hundred machines in Europe. These machines have been found very adaptable to European conditions, and with the feeder installation, have met with great favor.

Several other types of bottle machines of American manufacture are also found in England, and on the Continent.

The Owens bottle machine has made its way into England, and also on the Continent, and future developments of this machine are to be expected.

[1] Read before the Glass Division, Pittsburgh Meeting, February, 1923.

The Westlake bulb machine, made by the Libbey Glass Company of Toledo, is now operating in England, and more machines are to be installed. The introduction of this machine on the Continent is certain. Arrangements have been perfected for its installation in Germany, and other installations throughout Europe are planned in the immediate future.

The Danner tube machine, one of the most successful glass machines of recent years is in successful operation in England, and like the Westlake bulb machine, its introduction into Continental Europe is assured.

In addition to the above mentioned, there are other automatic and semi-automatic machines of American make that are finding favor in Europe.

The introduction of these machines into Europe will develop a new line of thought and endeavor in these countries.

In hand manufacture, the personal element helps to overcome many of the varying glass house conditions. Glass of varying temperatures can be controlled by the manipulations of the operator. Bad glass can be skimmed off, imperfections can be cut out by the individual workman, etc. In an automatically operated machine plant, the connecting furnace must have a constant supply of gas, uniform in composition and pressure. The variations in temperature of glass at different stations must be kept within very definite and unvarying limits, and all glass flow must be kept constant, and local deterioration of glass must be carefully avoided. The machine does not discriminate and uses glass as it comes.

These conditions have been fought out in this country and are still being fought. They are now being encountered in the new European installations, and glass house engineers and managers in those countries will do well to recognize the necessary changes. Those who observe them will get production, and those who do not, will blame the new machines.

To illustrate this point, I recall an experience I had with a feeder on a certain machine in Pennsylvania. The bottles produced were poor, and full of white specks, and while occasional runs were made successfully for short periods, the operations were very unsatisfactory. At the same time, the same installation at a nearby city was working very nicely. Examination showed that the operation of the furnace, and floating impurities in the glass caused all the trouble, and not the operation of the machine or feeder. As soon as the tank conditions were improved, the first plant operated as well as the other.

A great many of the troubles and production losses of all types of automatic glass machines may be traced to faulty glass conditions, faulty glass, and in some cases, glass of improper composition for efficient machine use. All of these conditions require a revision of the old type of glass house practice, and the best possible checks on the composition, the relation of temperature to composition, physical properties of the glass, design of the furnace, and many other factors must be considered.

A great many Americans travel abroad in company with their fellow citizens, and make observations and criticisms from our own view point entirely, without considering matters from the economic conditions existing in the countries being visited. In European countries, labor is plentiful, and we notice great labor wastes, with great conservation of building and raw materials, which are not so plentiful. In our own country, this condition is reversed, and the European traveler notices our economy of labor and the introduction of machines, with corresponding wastes in the materials he conserves.

In English glass plants, certain types of workers seem to be skilful, and rank perhaps better than the average American, but in other branches, such as bulb and tube plants, the workers apparently have been developed during war times, and have never acquired the skill of our American workmen.

The fuel problems of England are much the same as our own, and seem to be handled much the same way, and they are using similar grades of fuel. On the Continent, and especially in Germany, very poor fuel is used, and great care is exercised in their fuel installations. In Germany, I understand, they are now using much lignite as fuel in their producers.

Some of the old English plants are extremely interesting, the original plants, built many years ago, are still operated on the same grounds with modern installations, and it is possible to allow one's fancy to dwell on the romance of the glass industry.

The past war has been a great factor in bringing about changes, and before long, the characteristics of individual countries in this industry will gradually disappear. Abroad, they are adopting many of our ideas, and we, in turn, are manufacturing articles formerly made only in Europe, and before long, only slight differences of practice, as necessitated by local conditions, will be apparent.

TOLEDO, OHIO

THE IMPORTANCE OF FIGURING TAXES INTO COSTS[1]

BY F. T. OWENS

Introduction

"Why should we figure taxes into costs?" "We propose to pay our taxes out of our profits for this is what we have always done in the past, why should we change in the future?" One answer to this question is, If you are not going to consider taxes as an expense item in your business, how are you going to arrive at a proper selling price? This is the Yankee's plan of answering a question by asking another.

[1] Read before the Heavy Clay Products Division, Pittsburgh Meeting, February, 1923.

It might be interesting to note that today the interest alone on our public debt is upwards of $950,000,000, or approximately $250,000,000 more is paid now for interest than the entire cost of running this Government in 1906 and 1907. Someone must pay the taxes to enable the Government not only to pay its running expenses, but this tremendous item of interest as well. To those of you who have been following this question, a repetition of some figures will not be interesting, but there may be others who have not come in contact with these and I should like to bring out the point in a very splendid talk of James W. Good at the meeting in West Baden in December, in which he stated that the estimated cost for soldier relief alone for next year is $1,715,000,000. He stated further that if the future can be judged by the past that this sum must grow each year for a considerable number of years, for the tendency is to keep in mind the service rendered by our brave and noble soldiers and reward them accordingly as time goes on.

These taxes must be met, and they are collected from manufacturing industries.

Why should we figure them in our costs? I wish to call to your attention the thought that costs are figured for two reasons—the principle one being to make a selling price which will show a return on the capital invested in the business. In making this selling price, we must not only figure our direct costs, which cover items of material, labor, rental, insurance and similar expenses, but we must go a step farther and estimate as nearly as is possible what our taxes for the year are going to be.

If we could tell you today how you could make savings in your plant approximating $2000 to $10,000 per year, you would very likely be making notes that would enable you to put the plans described into effect. Why then should you overlook the thought of sitting down and figuring carefully just where you are going to arrive at the end of the year, provided you have a normal year's business, and in making this calculation figure at the same time the probable amount you will have to pay to your Government. When all this is done, you will be enabled to arrive at a cost basis which will fix a selling price adequate to pay a return on the capital, energy and time spent in the business.

Taxes are going to increase, not decrease. This means that in some lines of business more improved methods must be introduced in order to reduce the burden of cost and, while this burden of direct costs will be reduced, the manufacturer must hand over more and more of his earnings to the Government to help maintain it. In certain kinds of products, there is a limit to the cost that the public will pay and when it reaches a price which the purchasing public thinks too high, substitutes will be used and the business will gradually sink to oblivion.

Obsolescence

I also wish to direct your attention to the important matters of obsolescence and depreciation. There are none but will grant readily that the last five years have seen some wonderful strides made in the heavy clay products manufacture, and the next five years will see even greater changes in methods. I feel sure that the plant that is today up to date in every particular will be practically obsolete ten years hence. If not obsolete by reason of anything else than the cost of producing its material, for labor saving devices will be installed and installed so efficiently that the manufacturer who is not willing to add these to his plant will find himself with a cost so high he cannot demand a fair share of the business.

Depreciation

Sufficient depreciation should be figured on every unit of production to cover replacement when replacement must be made. A number of face brick plants have found that where the average production is 40,000 brick per day, the depreciation cost will run about 55 cents per M brick.

Do not make the fatal mistake of figuring depreciation on production alone, for your kilns will depreciate more rapidly by standing idle through a severe winter than they will if used daily. In figuring depreciation, take the average yearly production and reduce it to a monthly depreciation which will be charged whether the plant is operating or not.

A stabilized market is after all the best market in which to sell goods and if all manufacturers would approach their question of costs in exactly the same manner, then we would find fewer instances of men offering materials at prices way below that which their competitors can manufacture. These differences are not due in many cases to manufacturing methods—they are most often due to inaccurate cost methods.

If one manufacturer is setting out to reap a return of 15% net after all taxes are paid, how can he expect to compete with the man who figures that a 10% gross return is sufficient? How can any ordinary sized business today live on a 10% gross return when the turnover is hardly once in the year's business?

The department store turns over its investment four to six times a year on a 20 to 30% margin. The heavy clay products manufacturers do well if they turn over their investment one and one-half times a year. We are, therefore, entitled, justly so, to a larger return on this turnover than the business which can turn over its investment four to six times per year.

FISKE AND CO., INC.
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CLASSIFICATION AND SPECIFICATION OF FELDSPAR FOR USE IN VARIOUS INDUSTRIES

By James Turner

Introduction

The following remarks apply only to what I think would be desirable and serviceable for semi-porcelain, vitrified china, white electrical porcelain, white sanitary ware and white vitreous tile, of which I am somewhat familiar. In the other lines of ceramic manufacture I have no experience.

Chemical Composition.—Feldspar with an alkali content of 10% upward can safely be used in a body mix. This would therefore be the range of most feldspar or graphitic granite that is mined, ground, and sold commercially at this time.

The predominant alkali is potash in the ratio of about six to one of soda. However, I know of one good feldspar that has a ratio of about nine of potash to four of soda.

Exception may possibly be taken to the low alkali content given above so in justification will state that Cornwall stone with an alkali content of 6 to 7% has been exclusively used in another country for some generations in the manufacture of the various ceramic bodies that I have before enumerated.

The higher or lower alkali content is replaced by a lower or higher silica content, the alumina showing very little variation. This has been my observation of the analyses of many samples of feldspar.

The analysis should give no more than a trace of iron or other darkening minerals and when fused should be free from specks to any one with good eyesight. To expect an absence of specks when observed through a magnifying glass would place feldspar almost in the class of precious stones and therefore outside the purchasing power of the ceramic manufacturer. Also the production of feldspar to pass such a test would shrink to such small volume that it would have to be given up by the ceramic industry.

Color on Fusion.—Observation has shown that the same ground feldspar fired at different time-temperatures varies a little in shades of whiteness. A high silica and low alkali feldspar will change from a faint lilac tint at cone 7 to a clear white at cone 11. A high alkali and low silica content feldspar will change from the lilac tint at cone 7 to an almost transparent glass at cone 11.

As the range of fire of the various productions is from cone 8 to cone 12 and each manufacturer uses his own kilns to test out the feldspar he purchases, it seems to me that it would be impossible to fix one time-temperature as a standard to be used by all manufacturers.

Fusion Test.—In order to set a standard fusion test it would seem that the temperature, time and "soak" would of necessity have to be first standardized and this is a rather difficult undertaking.

To illustrate, in a small muffle of about ten by eight by six inches, a heat of about cone 11 half over may be developed in about four and one-half hours, giving a certain fusion on a standard sample of ground feldspar. The same result with the same feldspar will be obtained by firing in a round 16-ft. biscuit kiln in about 55 hours with cone 9 bent over. The reason for this is obvious. In addition to this with cone 11 half over in four and a half hours the same muffle kiln in successive firings the same feldspar may not be equally fused for sometimes the body of heat will hang longer in the muffle (after the fuel has been cut off) and therefore, in the vernacular of our business, "soak" whatever is in the muffle. In other words, the maximum heat will stay in the kiln longer one time than another.

This "soak" does not bring the cone down any lower but it will have the same effect on the material as though the heat had been raised an additional cone. This variation takes place in both small muffles and large kilns, so it seems that some additional check would of necessity have to be used to compare by burning the various shipments of feldspar for uniformity of color and fusion.

This can be done and is done by keeping a large standard sample of the feldspar that is being used and is of satisfactory color, fusion, cleanliness and fineness of grind. A small quantity of the standard sample should be put in the kiln with a sample of each new shipment. This comparison when fired even at a slightly higher or lower temperature, should be definite enough to determine whether the quality is reasonably uniform with the standard sample. Of course this is a very simple way, but I have not yet heard of any better method of testing for continuity of uniformity.

There are many manufacturers who prefer a feldspar that has a low alkali content their reason being that at the closing period of the fire (biscuit) they can give a longer soak and obtain the result they desire without so much risk of deformation.

Fineness of Grinding.—As to an arbitrary standard the same difficulty arises as in the standard for alkali content. The various manufacturers have different proportions of the component materials that make up their body. The ground materials (flint and feldspar) cover a range of from 50% to 60% of the bodies. Feldspar runs from 12% to 30% so the range of this material is very great. In vitrified china, there is a small proportion of the highly plastic ball clay used, owing to its detrimental effect on the color as shown in the translucency. Every means is used to obtain plasticity, one of which is the use of a china clay that combines as much as possible, color, plasticity and the strongest tensility, and another means is to use very finely ground flint and feldspar.

Comparatively large quantities of ball clay are used in semi-porcelain and white sanitary ware to obtain sufficient plasticity and strength for

the forming of the pieces of ware. This is especially necessary in sanitary ware owing to the size of the pieces and the strength required for handling in the green state. These large proportions of ball clay aid in vitrification, modifying the feldspar content and a somewhat coarser grind of feldspar would not be detrimental.

As white sanitary biscuit ware is fired at temperatures ranging from cone 8 to cone 11, the content of feldspar varies very considerably in their body composition. Some who fire at cone 8 like a feldspar of high alkali content hence low fusion point, while others use a "harder" feldspar to avoid blistering and to obtain a somewhat wider range of heat at the finish of the firing without detriment to the ware. Whether they use a "hard" or "soft" feldspar they have perforce by experience determined upon a suitable proportion of body materials and a certain temperature-time treatment in the firing of their kilns. These are standard. Whatever kind of feldspar has been found satisfactory, they would naturally desire to receive in continuous uniformity both as to quality and grinding.

The writer has found through a rather long experience in the manufacture of whiteware and in the grinding of feldspar, and a close touch with the desires and requirements of a number of excellent potters (whose excellency is attested by their productions) that a rejection of not more than one per cent on a 160's P. B. Standard lawn is satisfactory to all whiteware manufacturers. I know of one instance where a little more exacting standard is required and this calls for the equivalent of not more than three-quarters of one per cent rejection on a 160's P. B. lawn. On the other hand, manufacturers would be well satisfied if not more than $1^1/_2\%$ is shown on 160's P. B. lawn.

It is very difficult for a grinder who is producing in bulk a product of definite commercial uniformity with the mill and conveying apparatus arranged for the most economical movement of the product, to have various grades of fineness. These could be obtained with very little difficulty from the mills but the segregation in storage would be irksome and take up a great deal of space even if there were only three meshes of fineness.

When a grind of less than 1% on a 180's P. B. lawn has been offered chiefly as a glaze feldspar there has been very little demand for it. The same feldspar at 180's would have a little lower fusing point than at 160's, but when it is put into a glaze composition the whole goes into a cylinder or pan and is ground together for a period of from 20 to 30 hours according to the quantity of the batch, and the hardness of the frit, so that it gets some additional grinding.

A finer grinding might be more desirable where a raw electrical porcelain glaze is being compounded and mixed as this glaze is not so much ground as amalgamated.

Feldspar for Glazes.—For glaze purposes, some manufacturers

desire and insist on a very high potash feldspar with as little soda as possible and are of the opinion that a good glaze cannot be made without it. Others use a combination of two feldspars in the glaze and the finished product is beautiful and the reputation of the ware is excellent. Another potter uses the hardest of feldspars in his glaze obtaining his luster and fusion by increased use of other fluxes. Some potters desire for their glaze a feldspar with a very low fusion point and they get it, but it undoubtedly contains a considerable proportion of soda, though their glazes are good and their ware commercially satisfactory.

Summary

Summarizing, I do not think that a definite specification should be made for the alkali percentage in feldspar. If one were made I think that the great majority of users would ignore it as they would always adopt that which they thought would be best suited to the economy of their manufacture and the quality of their product.

However, I think that a ratio of six of potash to one of soda makes a desirable proportion and can be used in all manufactures.

The feldspar when fused should be free from specks visible to good eyesight.

The fused feldspar should be white drifting toward the warmer cream suffusion rather than a cold bluish white.

When fused its luster should reflect light.

Whatever the alkali content or tone of white it should be reasonably uniform in every shipment and the comparison can be made most surely by a firing test against a satisfactory standard sample. To my mind it is the continuous uniformity of the product that is of most value to the users, and not so much the alkali content.

The standard of grinding which I think would be very satisfactory to manufacturers is not more than 1% rejection on a 160's P. B. Standard lawn. I know so many able manufacturers of semi-porcelain, vitrified china, white electrical porcelain, white sanitary ware and white vitreous tiles who have found this standard suitable for their purposes.

COOK CHINA COMPANY
TRENTON, N. J.

DISCUSSION ON "SANDBLAST CASTINGS TO BE ENAMELED"[1]

J. GRAINER:—Has anyone had any experience with steel shot?

J. F. RITTER:—We commenced using steel grit in our plant in February, 1923, and we have practically eliminated the dust in our sandblast department.

[1] F. G. Jaeger, *Jour. Amer. Ceram. Soc.*, **6** [9], 976 (1923).

J. E. HANSEN:—I have been using crushed steel sold by the Pittsburgh Crushed Steel Company for the past two years. I could not use the sand because of the dust raised but have obtained good results with steel.

H. F. STALEY:—One of the companies for which I did considerable work has had some experience with crushed steel and shot. For quite a while they used a mixture of two-thirds crushed steel and one-third 30-mesh shot. Some time back they ran into considerable difficulty in that they found a deposit of graphite left on the castings after they had been sandblasted. Since then they have been using about 35% sand in the mixture with good results. Without the sand they do not get the castings bright and shiny as they want them.

M. E. MANSON:—What is the approximate cost of the sandblast?

F. G. JAEGER:—It requires about 50 h. p. to drive it. It also requires about 10 h. p. for the fan, making 60 h. p. in all. The cost would be about $2500.

We used some steel shot in connection with the sand but we found that if we did not use more force, the sand did not take effect on the ware.

J. GRAINER:—This is of vital importance to any one doing cast iron work. We are having considerable trouble with our wet white. Wet white has not reached that degree of perfection where it will overcome the slightest imperfection. The ware must be scrupulously clean. Would the steel shot polish the ware and get down into the iron? When one piece of ware is left in the blast for a minute, it is apparently clean. It is not clean, however, and the results are unsatisfactory. In justice to different firms that are using wet whites there may be some wet white that gives satisfaction, but the work must be cleaner than in the dry white.

A MEMBER:—In Wisconsin steel shot was used for three years or more. We found that it tears the material more than the sand. Sand apparently is safer and cheaper.

A Workman's Compensation Law in Wisconsin is more drastic than in most other states, which involves another question. There is always more dust in the sandblast room than is considered healthful. If a man stands in a draft and catches a cold, you pay him for his time off. Apparently the day is not far distant when they will absolutely prohibit the use of a room of that character. I understand that some of the other states are contemplating similar laws also.

We have been using a moving table. Only recently I had occasion to check up how much work can be done on that and I found it to be as much as eight thousand pounds in three hours. That is with a LaMotte blast.

F. G. JAEGER:—Did it have any effect in warping the casting?

W. C. LINDEMANN:—Yes. But if you take a piece it may warp on one side only.

A MEMBER:—We did not try the steel shot, but we have tried steel

grip. We have found that it must be dry or it will give trouble. Have you found the same tendency?

F. G. JAEGER:—When it is transported in wet weather it must be covered up to avoid getting wet.

W. C. LINDEMANN:—When we first went into sandblast enameling and for a year or two more we used hydrochloric acid, but sandblasting is far superior to the pickle. The discards on the pickle have dropped as much as 20 to 30%.

F. G. JAEGER:—We had some experience with another company, and we had the same trouble Mr. Lindemann described in the warping.

L. D. BRIDGE:—How much sand for a pound of casting is used? More specifically on a stove plate casting?

F. G. JAEGER:—That depends somewhat on the size of the castings. It would average about four thousand pounds of casting in eight hours, and we would use about one thousand to fifteen hundred pounds of sand. It also depends on the operator. If he is a good workman, you can get the average amount or better, and perhaps save on the sand.

B. T. SWEELY (Chairman):—Mr. Lindemann, is there a bill introduced in your state in regard to spraying?

W. C. LINDEMANN:—There was a bill before the legislature two years ago prohibiting spray guns. That would prohibit the use of spray guns in any work that might be objectionable to the health. It is again before the Legislature, and there is considerable propaganda out. The manufacturers are endeavoring to show that it is not injurious to the health. I understand that it is being brought up by the painters in the Chicago, Milwaukee and St. Paul workshops, who are strongly unionized, together with the American Federation of Labor.

CHAIRMAN:—It is started by the unions in a short-sighted policy in opposition to labor saving devices. The same bill is up before the California legislature.

E. HOGENSEN:—Some of this trouble is due to improper fans being used. Oftentimes the manufacturers themselves are to blame for not using larger fans.

B. T. SWEELY (Chairman):—Do you know how far this legislation has gone?

E. HOGENSEN:—Only in California and our neighboring states.

CHAIRMAN:—It would be of considerable interest to the Division to know. If this thing is going to be acute, we shall have a great deal of trouble on our hands. On most of the flat work, spraying has come to be almost the universal method of applying the enamel.

DISCUSSION ON "SUBSTITUTING OIL FOR PRODUCER GAS"[1]

W. W. OAKLEY:—Will you give us the cost of the oil per gallon; also whether they tried any sheet flame burners?

F. S. THOMPSON:—The price of the oil was 4½ cents in the car on our siding. We did not use sheet flame burners. The plant under discussion is located in New England.

J. C. HOSTETTER (Chairman):—Oil is somewhat cheaper there due to the fact that it is brought in by boat; perhaps Texas or Mexican oil is used. The glass pull is 15 or 16 tons, is it not?

F. S. THOMPSON:—Yes, the tonnage pull is approximately 16 tons. The designed capacity is 20 tons.

A MEMBER:—How about the pressure necessary on that burner in order to get flame? Is it necessary to use excessive pressure?

F. S. THOMPSON:—At the start we used air at 60 pounds, afterwards steam under 100 pounds at the boiler and 70 pounds at the burner.

CHAIRMAN:—This oil is cheaper than we get it in Corning.

G. AURIEN:—What is the gravity of the oil?

F. S. THOMPSON:—18 to 20. The price of coal is $9.50. At that time it was about $8.00 delivered in New York.

Mr. Milford cited an instance where heavy Mexican crude oil was used to heat a recuperative furnace. The burners were located at the rear of the furnace and the charging took place at the side. The oil was fed to the burners under considerable pressure with the result that the flame extended about two-thirds of the distance of the melting chamber of the tank.

Whenever the tank was charged with new batch the dusty portion would be swept along by the flame and would be deposited in the recuperator passages with any condensed volatile products.

An examination was made of some of the fused material taken from the recuperator passages and it was found to contain large percentages of soda ash, lime and sulphur compounds. It also showed about 5% arsenic.

Mr. Milford stated that the oil worked satisfactorily in a recuperative furnace.

G. AURIEN:—I came particularly to get information. We have all had some little experience in burning oil. The question arises in my mind as to whether or not a heavy gravity oil in a narrow furnace, say 16 feet in width, would be more expensive or less on account of combustion or non-combustion, compared to 30 gravity oil. It has been our experience that the heavy gravity oil takes longer to form complete combustion resulting in a waste. I would like to hear an expression of opinion from

[1] F. S. Thompson, *Jour. Amer. Ceram. Soc.*, **6** [10], 1050 (1923).

someone who has had the same kind of an experience, whether a lighter oil would be more beneficial than a heavy one in a narrow furnace.

CHAIRMAN:—We have a large number of combustion engineers with us.

J. F. Greene explained that at about the time the coal strike came along they had a furnace built with a recuperator and a high pressure oil system was installed whereby oil was atomized at one side, at the back of the furnace and the exhaust flue was on the other side, giving them a horseshoe flame.

On installing this system we were advised to use a Pennsylvania residuum oil of about 32° Baumé. The oil system company stated that the best results were obtained with this oil.

We were making a rather hard glass in this furnace and to keep the boots hot were obliged to force the fire well down into the nose. We found it impossible to get clean glass in the boots, even with this high grade light oil. Standard oil of the same gravity was no worse and no better than the pure Pennsylvania oil. The primary and recuperator air supplies were varied systematically in the attempt to find good working conditions. Flue gas analyses showed practically no CO with varying amounts of CO_2 and excess oxygen. But the deposition of carbon on the glass continued.

Later we made a softer glass in this tank with complete success. In this case we used more stack and were able to keep the fire away from the boots.

The dirtying of the glass was due, evidently, to a deposition of carbon during the passage of the flame through the furnace, and occurred in spite of sufficient air supply, good mixing, and a light clean fuel oil. The successful application of fuel oil to a glass melting furnace, especially for the manufacture of high grade ware, requires that the glass, the furnace, and the oil system be chosen so as to work well together. Each one of these three elements must be considered in its relations to the other two.

CHAIRMAN:—Was the oil pre-heated?

J. F. GREENE:—Yes, at the central pump house, and supplied to the burner at a little over 100°F.

DISCUSSION ON "PRODUCER GAS FOR BURNING REFRACTORIES"[1]

A. F. GREAVES-WALKER:—The refractories manufacturers at the present are much interested in the development of the railroad tunnel kiln for the burning of refractories. There seems to be a question in the minds of those interested as to the value of producer gas and one of the things that is worrying them is the question of firing at high temperatures. We can safely

[1] W. D. Richardson, *Jour. Amer. Ceram. Soc.*, **6** [7], 799 (1923).

profit by the experience of the European refractories manufacturers. The American Refractories Company is operating a kiln in Austria burning 50 tons of magnesite a day with brown coal producer gas. They are getting cone 20 continuously without any difficulty. Dr. Otto and Company of Dahleisen, Bendorf, Germany, are operating four kilns producing 40 thousand silica brick per day in each kiln and getting cone 14, using high volatile coal from the Lower Ruhr district. I think if there is any question about adaptability of producer gas, those examples should prove that there is no ground for it.

P. H. DRESSLER:—We have used producer gas to a large extent and can state that there is no trouble at all in reaching high temperatures, provided you have preheated air.

In regard to one of the points Mr. Richardson made concerning the use of steam in producers, I think, as a rule, it is found that where the gas is used very close to the producer there is every advantage in using the least volume of steam. Where the producer is quite a long way from the point of application of the gas and there is much cooling in the ducts, it is advantageous to use more steam and make a gas with a higher hydrogen content and a lower sensible heat. In this way more B.t.u.'s are delivered to the furnace. I believe it is considered by most of the producer gas experts that the sooting of the ducts is very largely due to the decomposition of the carbon monoxide into carbon dioxide and carbon which takes place at a low red heat. This is a reversal of the reaction which takes place at higher temperatures in the producer itself where carbon dioxide reacts with carbon to give carbon monoxide. There is, therefore, an advantage in making a fairly cool gas since this cuts down the sooting of the ducts. Where very hot gas is used, as for instance is common in the steel mills, the ducts clog up very rapidly.

MR. NORTHEY:—Mr. Richardson spoke of the compartment kiln as being more serviceable for burning the different sizes of material than the car tunnel kiln. In the compartment kiln, all compartments would burn practically the same. Just in which way will the compartment kiln accomplish this to better advantage than the tunnel kiln?

W. D. RICHARDSON:—Each chamber of a compartment kiln is fired independently, so that more time can be taken with any compartment and the finishing temperature may be higher or lower in one compartment than in another. In a tunnel kiln to make such variations in time and temperature interferes more or less with its operation, and the best results are obtained when the cars are all set in the same manner, with the same size of ware, and the speed of the cars through the tunnel is uniform. Moreover, the cooling of the ware in a tunnel kiln is necessarily rapid for economical operation while large bodies should be cooled more slowly than small ones. So I have said that the compartment kiln has greater flexibility.

You can burn any kind of clay product in it and give any compartment such time and temperature as may be required without detriment to operations in other compartments.

D. W. Ross:—Can you readily burn in your compartment kiln one chamber at cone 1, 2 or 4 and the next chamber at cone 10?

W. D. Richardson:—Yes.

D. W. Ross:—Without any special loss of heat?

W. D. Richardson:—Yes.

C. E. Bales:—I would like to ask the opinion of Mr. Richardson of the use of producer gas in round, down-draft periodic kilns.

W. D. Richardson:—Producer gas is being burned successfully in periodic kilns, where only moderate temperatures are required. Just how high temperature can be practically attained, using air at atmospheric temperatures, I do not know, but certainly not high enough for refractories. It would be practical, in some cases, to preheat the air for combustion with the heat of cooling or burning kilns and attain somewhat higher temperatures but the results would not be satisfactory in the fire brick industry.

Referring once more to the point of comparison between the tunnel kiln and the compartment kiln for firing shapes, Mr. Richardson pointed out, and the point was well taken, that it was possible to a certain extent to separate the small and large shapes in a compartment kiln, thus preventing the loss of production due to the slow firing required for large shapes. Most of the large shapes I have seen in a brickyard are not capable of being piled up to any height in a compartment kiln. They can only be set in the upper courses. That being so, this argument somewhat loses its force. Furthermore, it appears to me that whether the small and large shapes are set separately in different compartments or together in the same compartment, it makes no difference to the production of the kiln since if one compartment takes longer to fire off than usual this prevents the next compartment from being finished, it not being possible to have two compartments on full fire simultaneously. In this respect the compartment kiln is in exactly the same position as the tunnel kiln where if you have to hold some material longer in the heat zone it naturally delays the operation.

D. W. Ross:—I do not know whether that applies particularly to the problem in hand. The refractories of the glass industry are about as irregular as any clay shapes there are. They will normally pile about three high, thus filling the ordinary rectangular kiln to near its crown. It appears probable that such shapes would pile conveniently in the filling of the compartments.

MEMORANDUM ON POWER SITUATION IN THE UNITED STATES IN MILLION HORSEPOWER

By S. S. Wyer

The diagram (Fig. 1) shows the power situation in the United States in million horsepower. The diagram at the left shows that the present de-

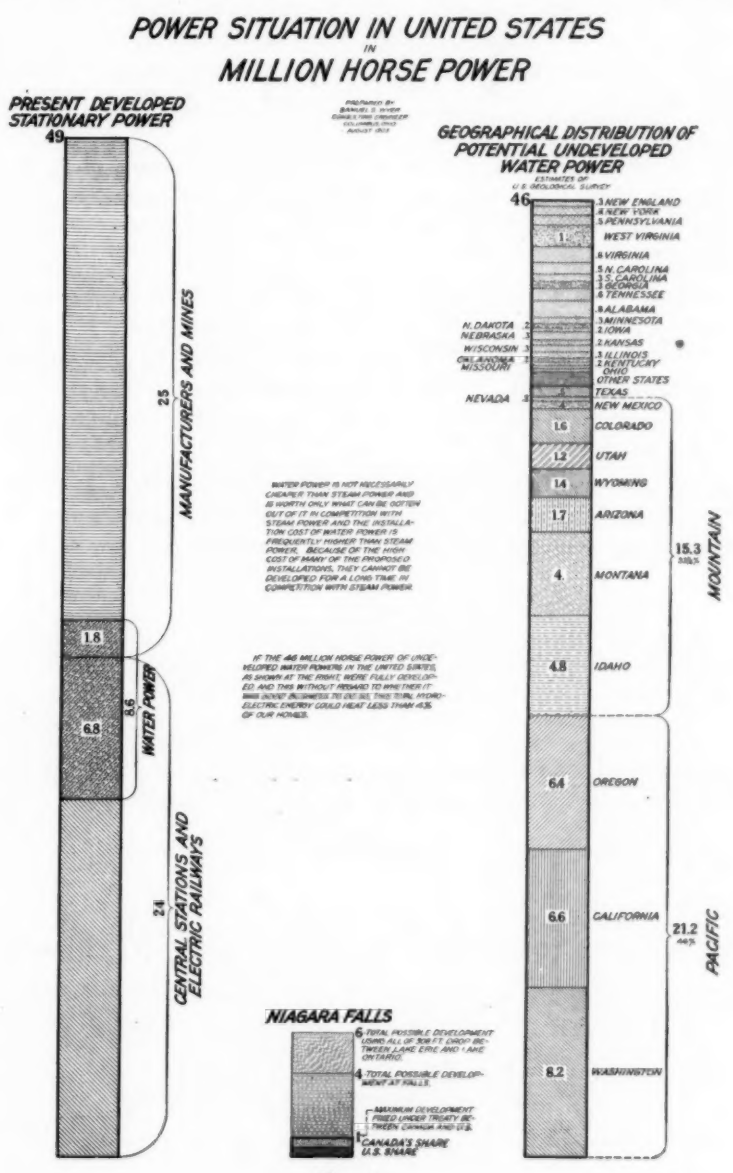

FIG. 1.

veloped stationary power is, in round numbers, 49 million. Of this total developed stationary power, 6.8 million water power is used in central stations and electric railways and 1.8 million water power is used in manufacturing plants and mines.

The diagram at the right, shows that there is 46 million horsepower of undeveloped water power in the United States and the vertical classification shows the geographical distribution. An interesting notation here is that 46% of the 46 million horsepower, or 21.2 million, is in the three Pacific Coast states, while 33%, or 15.3 million, is in the Rocky Mountain states.

If this entire 46 million horsepower of undeveloped water power in the United States were fully developed, and this without regard to whether it was good business to do so, the total hydro-electric energy could heat less than 4% of our homes.

The insignificance of Niagara Falls in relation to the total power situation is shown in the middle. If all of the flow of the Niagara River and the total head between Lakes Erie and Ontario were used, 6 million horsepower could be developed. If the head at the Falls alone was used, without using the drop in the whirl pool and rapids below, 4 million horsepower could be developed.

The treaty between the United States and Canada limits the total development to one million and out of this the United States' share is 400 thousand horsepower and Canada's 600 thousand horsepower.

ACTIVITIES OF THE SOCIETY

PRESIDENT'S PAGE

The entire SOCIETY is to be congratulated on the fact that during the past eleven months a larger number have joined the Society than during any previous twelve months. The number of withdrawals is less than last year. This bespeaks a heartening growth in appreciation of the value of this coöperative enterprise. To the Membership Committee is due especial praise for their effective plans laid for presentation of the opportunities of membership, but the solid worth of the SOCIETY in things accomplished is the basic reason for this substantial increase. While the increase in the SOCIETY'S roster is evidence of essential work well done by the Membership Committee the greater reason for congratulation lies in the recognition they thus obtained for the real service being rendered.

It is my hope that the members will continue without abatement their presentation of the opportunities and benefits of membership in the SOCIETY. Only if this is done will the next budget committee feel justified in carrying on the present program, and it is impossible to think of failure after going so far.

* * *

The report of the Nominating Committee insures the SOCIETY of a strong and progressive board next year. Great things may be expected of them.

* * *

Georgia Tech is about to begin work on its new ceramic school. The legislature has appropriated $20,000, the ceramic interests of Georgia and the South $20,000, the Atlanta *Constitution* $8000, and the land on which the school is to be built has been donated. This is a splendid start for the new enterprise and speaks well for the clay-workers of Georgia, who have worked so hard to esatblish this, the first ceramic school below the Mason and Dixon Line.

* * *

The Committee on Papers and Program have outlined a splendid program for the Atlantic City meeting, but it will be necessary for every member to do his share to make it a success. The call for papers has gone out, and the officers hope for a generous response.

* * *

Application for a Section Charter has been made by the SOCIETY'S members on the Pacific Coast. There is no doubt that this Section will fill a great need on the Coast, the members being so far removed from the center of the SOCIETY'S activities in the East. The officers and members of the SOCIETY extend best wishes for success to the new Section.

NOMINATION FOR OFFICERS AND TRUSTEES FOR 1924

Persons placed in nomination by the nominating committee for officers and the nominees for Division representative on Board of Trustees are as follows:

President—Robert D. Landrum, Cleveland, Ohio.

Vice-President—Raymond M. Howe, Pittsburgh, Pa.

Treasurer—H. B. Henderson, Columbus, Ohio.

Trustees—

Art Division (1 year)—F. H. Rhead, Zanesville, Ohio

Enamel (1 year)—R. R. Danielson, Washington, D C.

Refractories (1 year)—J. S. McDowell, Pittsburgh, Pa.
Glass (2 years)—J. C. Hostetter, Corning, N. Y.
White Wares (2 years)—C. C. Treischel, Pittsfield, Mass.
Heavy Clay (3 years)—C. Forrest Tefft, Watsontown, Pa.
Terra Cotta (3 years)—R. L. Clare, Woodbridge, N. J.

Article V, 2. "Any ten Active Members may constitute a self-appointed Nominating Committee and present names of nominees for President, Vice-President, and Treasurer to the Secretary for placement on the election ballot, provided such names are presented at least thirty days before the annual meeting."

In case of failure of election the Board of Trustees will at the time of the annual convention make appointments to fill the vacancies as provided for in Article IV, paragraph 12 of the Constitution.

All of the above-named nominees have accepted the nomination.

THE SOCIETY MAY BE GLORIFIED IN ITS GOOD WORK, BUT IT NEEDS OPPORTUNITY AND SUPPORT

Last June note was made of the fact that the membership had that month passed the 2000 mark. The 2200 mark was passed this month. Mention of this is only in passing for in fact it is only "in passing." The SOCIETY is on the way to obtaining that strength which the magnitude and character of the ceramic industries demand.

That the work which the SOCIETY is doing is being appreciated more and more is shown in the following data. These data, however, tell more than appreciation, they speak loud in terms of expectation. More members and greater facilities bring larger opportunities and greater obligations, and it is just these that the members of the SOCIETY are on their toes to meet to the full. Here is the record to date.

				Gain		
	Personal	Corporation	Total	Personal	Corp.	Total
January, 1922	1350	139	1489			
January, 1923	1611	216	1827	261	77	338
November, 1923	1930	284	2214	319	68	387

The net gain in members during the month of October 15 to November 15 was 68 personals, 30 corporations. There is one more month remaining in 1923 to make the record of corporation additions exceed the 1922 record of 77 new members. Rather than 68, the total corporation additions for 1923 should be 200. This is possible if every member does his share, thus increasing the opportunities for more effective promotion of the Ceramic Arts and Sciences.

NEW MEMBERS RECEIVED FROM OCTOBER 15 TO NOVEMBER 15

PERSONAL

Robert Ahrens, 850 E. 5th St., St. Paul, Minn., Foreman of Porcelain Division, Seeger Refrigerator Company. (Reinstated.)

Robert J. Anderson, U. S. Bureau of Mines, Pittsburgh, Pa., Metallurgical Engineer.

Yngve R. Anderson, University of Saskatchewan, Saskatoon, Sask., Canada, Student Member.

Stanley Aronson, 5043 Franklin Ave., Los Angeles, Calif., Electric Furnace Dept., Research Lab., Vitrefax Co.

B. C. Berg, 5332 Santa Fe, Los Angeles, Calif., President Schurs, Oil Burner Company.

M. E. Blackburn, 18th and Union Sts., Bellaire, Ohio.

G. Ray Boggs, 612 Pacific Mutual Bldg., Los Angeles, Calif., Manager, American Clay Company and American Grinding Company.

Carl D. Bossert, 66 S. Third St., Columbus, Ohio, Civil Engineer.

Paul C. Boving, Pomona, Calif., Manager Pomona Tile Mfg. Company.

Wray G. Brady, 600 American Bank Bldg., Los Angeles, Calif., Secretary, Pacific Clay Products, Inc.

Oscar Brewer, 4901 Stenton Ave., Philadelphia, Pa., Sales Engineer, Leeds & Northrup Company.

Judson F. Clark, 285 W. Mountain St., Pasadena, Calif., President and Treasurer, Pomona Tile Mfg. Company.

Holt Condon, 189 S. Michigan Ave., Pasadena, Calif., Ceramic Engineer, Batchelder Wilson Company.

W. H. Cook, 608 Angeleno Ave., Burbank, Calif., Supt., Empire China Co.

W. S. Cook, Virginia Apartments, Parkersburg, W. Va., General Porcelain Company.

J. R. Crouch, c/o Pittsburgh Plate Glass Company, Charleroi, Pa., Assistant Superintendent.

Phillip H. Cruikshank, c/o H. Mueller Mfg. Company, Decatur, Ill.

E. M. Davids, Tropico Potteries, Glendale, Calif., Secretary.

J. L. Davis, 143 N. Daly St., Los Angeles, Calif., Superintendent, Pacific Clay Products, Inc.

Herbert R. Dickey, University of Saskatchewan, Saskatoon, Sask., Canada, Student Member.

Leon A. Dougherty, 1045 Fourth Ave., Astoria, N. Y., Ceramist, N. Y., Architectural & Terra Cotta Company.

Finlay M. Drummond, Jonathan Club, Los Angeles, Calif., Vice-President and General Manager, Alberhill Coal & Clay Company.

Robert W. Ellison, 112 N. Alta Vista, Monrovia, Calif., Chemist, The Vitrefax Co.

Stewart Findley, Los Angeles, Calif., Manager, Emsco Clay Co.

William J. Geddes, 611 Interstate Trust Bldg., Denver, Colo., Superintendent, Denver Sewer Pipe & Clay Company.

Karl Hart, 111 N. Rugby Ave., Huntington Park, Calif., Maintenance Supt., The Vitrefax Co.

Grant O. Herb, 2819 13th St., Washington, D. C., Junior Ceram. Engr., Bur. of Standards.

C. A. Hoppin, 607 Central National Bank Bldg., Peoria, Ill., President, C. A. Hoppin and Company.

F. T. Houlahan, 3700 9th Ave., S. Seattle, Wash., President, Brick and Tile Mfg. Company.

Henrietta O. Jones, St. Louis School of Fine Arts, Washington University, St. Louis, Mo.

Julius A. Kayser, 4943 Lansdowne Ave., St. Louis, Mo., Assistant Ceramist, Laclede-Christy Clay Products Corporation.

Henry Frank Lee, 2421 E. 55th St., Los Angeles, Calif., Ass't Supt. Production, The Vitrefax Co.

Wager Lewis, Cranberry Creek, N. Y., Superintendent, Gloversville Feldspar Company.

Daniel C. Lindsay, Bureau of Standards, Washington, D. C., Ceramic Division.

Robert Linton, 600 American Bank Bldg., Los Angeles, Calif., General Manager, Pacific Clay Products, Inc.

Cecil V. McClintock, Whittier, Calif., Route No. 2, Box 227, Pacific Clay Products, Inc., Plant 6.

Earl McClintock, 4556 N. Griffin Ave., Los Angeles, Calif.

William McClintock, 215 East Ave., 41, Los Angeles, Calif., Superintendent, Pacific Clay Products, Inc.

Al. J. Mesmer, Superintendent, St. Louis Fire Brick & Clay Company.

Frederick A. Moffat, Moffats Ltd., Weston, Ontario, Canada, General Manager and Treasurer.

Thomas A. O'Shaughnessy, 4705 N. Winchester Ave., Chicago, Ill., Color Dept., N. W. Terra Cotta Company.

Campbell Patch, Haws Refractories Company, Johnstown, Pa., Secretary and Treasurer.

Charles W. Peddrick, Jr., 170 Broadway, New York, N. Y., General Manager, Gloversville Feldspar Company.

W. H. Pelletier, 2226 Dennison Ave., Cleveland, Ohio, Chemist, Ferro Enameling Company.

Walter A. Preische, Alfred, N. Y. (Student Member).

Edward Reynolds, Santa Barbara, Calif., Manager, Unit Brick and Tile Company.

Robert Roadhouse, 49 Wooster St., Norwalk, Ohio, Enameler.

Rhoda L. Robbins, 229 Market St., Bloomsburg, Pa., Potter.

H. A. Rossell, Box 414, Bristol, Tenn., Mill Manager, Mineral Products Company.

Ichiro Shimada, Ebie Wishinarigun, Osaka, Japan, Glass Manufacturer.

J. F. Sinclair, c/o Jeffery-Dewitt Insulator Company, Kenova, W. Va., General Manager.

Krishen Singh, Katni Cement Factory, P. O., C. P. India.

James V. Slade, 38 S. Dearborn St., Chicago, Illinois, Chicago Manager, Dorr Co., Inc., Engrs.

Fred O. Slasor, 4419 S. Normandie Ave., Los Angeles, Calif., Superintendent, American Encaustic Tiling Company, West Coast Plant.

F. W. Spring, Metters, Ltd., Mitchell Road, Alexandria, Sidney, P. S. W., Australia, Enameler.

Walter G. de Steiguer, 1314 Bank St., S. Pasadena, Calif., Tropico Potteries, Inc., Superintendent, Tile Department.

Roger H. Stitt, 137 Hyland Ave., Ames, Iowa, Student.

G. C. Stoll, 211 Higgins Bldg., Los Angeles, Calif.

Justin C. Sturm, 76 E. Walton Place, Chicago, Ill., Inland Glass Company.

Arthur P. Taylor, 706 Burns St., Cincinnati, Ohio, Secretary and Treasurer, The Chas. Taylor Sons Company.

Clifford Tillotson, Route No. 2, Box 938, Los Angeles, Calif., Manager, Atlas Fire Brick Company.

Howard Webster, 702 Harrison Bldg., Philadelphia, Pa., Consulting Engineer.

Arch T. Weisgerber, Box 353, Alliance, Ohio, Production Manager, Crescent China Company.

Hugh E. Weightman, 608 S. Dearborn St., Chicago, Ill., Director, Research Division, Mophite Company.

A. H. C. Wenger, Messrs. Wenger, Ltd., Etruria, Stoke-on-Trent, England.

G. A. Wild, 605 Lankenlim Bldg., Los Angeles, Calif., President, Western Brick Company.

A. T. Wintersgill, 411 N. Louis St., Glendale, Calif., Salesman, Pacific Clay Products Co., Inc.

John Frederick Wynn, Beech Creek, Pa., Supt., General Refractories Company.

CORPORATIONS

American Lava Corporation, Electric Insulation, Chattanooga, Tenn. John Krusei, President.

The Atlas China Co., Mfgrs. of Semi-porcelain, Niles, Ohio. A. O. C. Ahundts, President and Treasurer.

Ball Brothers Co., Glass Mfgrs., Muncie, Ind., George A. Ball, Treas.

The Beach Enameling Co., Enameled Signs, Coshocton, Ohio.

Challenge Refrigerator Co., Grand Haven, Mich., E. O. Harbeck.

Columbian Enameling and Stamping Co., Mfrgs. of Enameled Ware, Terre Haute, Ind. Werner H. Grabbe.

Detroit Star Grinding Wheel Co., 111 Cavalry Ave., Detroit, Mich. Frank H. Whelden, Secy. & Treas.

The Dolomite Products Co., Producers of Dolomite Refractories, 1110 Euclid Ave., Cleveland, Ohio. H. P. Gells, Jr., Pres. and Gen. Mgr.

Findlay Clay Pot Co., Washington, Pa.

Florida China Clay Co., Producers of Florida China Clay, Box 83, Leesburg, Fla. L. A. Morris, Secy. & Treas.

Friderichsen Floor & Wall Tile Co., 215 E. Kansas St., Independence, Mo.

William J. Geddes, Denver Sewer Pipe & Clay Co., 611 Interstate Trust Bldg., Denver, Colo.

Gill Clay Pot Co., Mfgrs. Clay Pots and Tank Blocks, Muncie, Ind. Charles O. Grafton.

Jeffery-Dewitt Insulator Co., Kenova, W. Va. J. F. Sinclair, Gen. Mgr.

Kohler Co., Enameled Plumbing Fixtures, Kohler, Wis. Walter J. Kohler, Pres.

Lapp Insulator Co., Inc., Electrical Porcelain, Leroy, N. Y. G. W. Lapp.

Metropolitan Paving Brick Co., Mfgrs. paving brick, common brick and hollow tile, Canton, Ohio. R. B. Keplinger, Asst. Gen. Mgr.

Missouri Fire Brick Co., 418 Security Bldg., St. Louis, Mo.

Mitchell-Bissell Co., 334 Fourth Ave., New York City. John A. Williams, Asst. Secy.

New Jersey Pulverizing Co., 15 Park Row, New York City. Harry F. Spier, Pres.

New Jersey Terra Cotta Co., Mfgrs. of Terra Cotta, Singer Bldg., New York City. E. V. Eskesen, Pres.

The Northwestern Terra Cotta Co., Mfgrs. of Architectural Terra Cotta, 2525 Clybourne Ave., Chicago, Ill. A. F. Hottinger.

J. M. Seasholtz, Porcelain Enameling, Front and Spruce St., Reading, Pa.

The A. A. Simonds-Dayton Co., Grinding Wheel Mfgrs., N. Summit St. and Negley Place, Dayton, Ohio, Frank R. Henry, Secy.

Simplex Engineering Co., Washington Trust Bldg., Washington, Pa. C. E. Frazier, Pres.

United States Gauge Co., Sellersville, Pa. W. H. Lentz.

United Clay Mines Corp., Trenton, N. J. C. C. Engle, Gen. Sales Mgr.

The Vitrefax Co., Refractories, 51st & Pacific Blvd., Los Angeles, Calif.

Wishnick Tumpeer Chemical Co., Importers and Dealers in Chemicals, Oils, Colors, 365 E. Illinois St., Chicago, Ill. Michael Agazim.

Waltham Grinding Wheel Co., Waltham, Mass. M. F. Cunningham, Gen. Mgr.

Membership Workers' Record

Name	Personal	Corporation	Name	Personal	Corporation
Alice A. Ayars	1		John M. Dell		1
L. L. Beeker	1	1	Frederick W. Donahoe	1	
George Brian		1	B. K. Eskesen		1
E. N. Bunting	1		Geo. P. Fackt	1	1
Paul E. Cox	1		F. C. Flint		3
R. R. Danielson	2		H. C. Goodwin		1
H. E. Davis	1	2	Roland W. Gouin	1	

Name	Personal	Corporation	Name	Personal	Corporation
F. M. Hartford	1		A. R. Payne	1	
T. D. Hartshorn	1		F. H. Riddle		2
John Herzog	1		W. S. Roberts		1
L. C. Hewitt	1		John Sawyer	8	
Frank Humpel		1	Homer F. Staley	1	
E. C. Hunting	1		Gail R. Truman	2	
E. L. Hutchinson	1		Gus M. Tucker	1	
Herbert Goodwin	1		Karl Turk	1	1
R. M. King		1	W. E. S. Turner	1	
W. M. Jacobs	1		W. F. Wenning	1	
A. A. Klein	1		Otto W. Will	1	
H. J. Knollman	4		Hewitt Wilson	1	
Paul S. MacMichael	1		W. G. Worcester	2	
Werner Malsch	1		R. C. Zehm	1	
Ellsworth Ogden	1		A. S. Zopfi		1
Fred Ortman	8	1	Office	11	1
W. G. Owen	1			—	—
C. W. Parmelee	1			68	30

PERSONAL ACTIVITIES OF SOCIETY MEMBERS

Roy C. Brett has moved from 1697 Lee Road to 1545 Parkhill, Cleveland, Ohio.

John Campbell who has been employed with the Asbestos Wood Co., Nashua, New Hampshire has moved to Canada where he is located with the Abitibi Power and Paper Co., Iroquois Falls, Ontario.

F. F. Carhart is living at 727 Forty-first street, Des Moines, Ia., having moved from Sheffield, Iowa recently.

Sandford S. Cole, formerly instructor in the department of Ceramics, at the University of Illinois has moved to Pittsburgh, Pa., where he is located in the Koppers Laboratory, Mellon Institute.

Herman L. Cook is now located at Stevens Brothers and Co., Stevens Pottery, Ga. Mr. Cook formerly lived in Danville, Ill.

James A. Davies who has been filed among "members lost" lives at Parkwood Drive, Cleveland, Ohio.

J. A. De Celle has moved from Waukegan, Ill., to 131 N. Sheridan Road, Highland Park, Ill.

Redfield Dinwiddie recently of Somerville, N. J. has removed to 213 W. 21st street, New York City.

Bert De Witt formerly of the Belmont Stamping and Enameling Co., New Philadelphia, Ohio, is now with Genderp-Paeschke and Frey of Milwaukee, Wis.

W. Russell Greer gives 612 Hollen Road, Baltimore, Md., as his correct address.

F. P. Hall who has been with the Bureau of Standards, Washington, D. C., has moved to 884 Massachusetts Ave., Cambridge, Mass. Mr. Hall is taking graduate work in the department of Physical Chemistry, Massachusetts Institute of Technology.

Herman A. Hall, formerly of Medina, Ohio, is now with the Graham Clay Products Co., Conneaut, Ohio.

John H. Kennedy has moved from Canandaigua, N. Y , to 243 Pulteny St., Geneva, N. Y. Mr. Kennedy is employed with the Lisk Manufacturing Co., Ltd.

S. Spicer Kenyon has removed from 2214 15th street to 2490 Pierce Ave., Niagara Falls, N. Y.

Harry J. Knollman writes that his new address is 1210 W. 28th street, Los Angeles, Calif.

F. M. Koenig, manager of the Schoonhoven Pottery, Schoonhoven, Holland notified the Secretary's office that his address is Bergen street, Brooklyn, N. Y.

James W. Moncrieff of Stockton, Calif., is living at 1215 Pine street.

William E. Rice of Alliance, Ohio, is employed with the U. S. Bureau of Mines, 4800 Forbes street, Pittsburgh, Pa.

Fred Sauereisen of the Technical Products Co., has been transferred from East Liverpool, Ohio to the Pittsburgh Office, 116 South Sheridan Ave.

H. H. Stephenson, formerly of Montreal, Canada has accepted a position with the American Encaustic Tiling Co., Zanesville, Ohio.

Lawrence A. Vincent has moved from Zanesville, Ohio to New Castle, Pa.

R. T. Watkins is living at 1410 W. University Ave., Urbana, Ill. Mr. Watkins is an instructor in the Department of Ceramics, University of Illinois.

Glen D. Williams has moved from Waukegan, Illinois to Worcester, Mass.

William A. Yung has moved from Harrison, N. J. to Pittsburgh, Pa. where he is employed with the Macbeth-Evans Glass Co.

NEW ENGLAND SECTION FALL MEETING

By C. H. Lawson[1]

The Fall Meeting of the New England Section of the American Ceramic Society was held at the Boston City Club on Saturday Evening, October 27th at 7 o'clock P.M. with the following members present:

William Pettignew, The Norton Co., Worcester, Mass.
Albert S. Adcock, The Norton Co., Worcester, Mass.
C. A. Underwood, Queen's Run Refractories Co., Boston, Mass.
W. A. Robertson, Dedham Pottery, East Dedham, Mass.
Glenn D. Williams, The Norton Company, Worcester, Mass.
L. B. Bassett, Baxter D. Whitney & Sons, Inc., Winchendon, Mass.
A. C. Postley, The River Feldspar & Milling Co., Middletown, Conn.
J. M. Grafton, Boston Pottery Company, Boston, Mass.
S. H. Slobodken, Boston Pottery Company, Boston, Mass.
E. D. May, Baxter D. Whitney & Son, Inc., Winchendon, Mass.
Arthur T. Malm, The Norton Company, Worcester, Mass.
C. B. Tilton, Cortland Grinding Wheel Corp., Chester, Mass.
A. A. Klein, The Norton Company, Worcester, Mass.
M. F. Cunningham, Waltham Grinding Wheel Company, Waltham, Mass.
Geo. Henderson, Dorchester Pottery Works, Dorchester, Mass.
Harold E. Bigelow, New England Porcelain Co., Hudson, Mass.
J. Fred Stingel, New England Porcelain Co., Hudson, Mass.
Arthur E. Baggs, The Marblehead Potteries, Marblehead, Mass.
C. H. Lawson, Waltham Grinding Wheel Company, Waltham, Mass.
Ross C. Purdy, American Ceramic Society, Columbus, Ohio.

General Secretary, Ross. C. Purdy, gave an inspiring talk on "Recent Developments in the Ceramic Industries and the value of Coöperative Research."

This proved to be of considerable interest to all the members and brought forth many questions and discussions.

[1] Secy-Treas. New England Section.

The rest of the evening was devoted to informal discussions of general interest.

The next meeting is planned for January but the exact date has not as yet been decided upon.

ST. LOUIS SECTION MEETING

The members of the St. Louis local section held a meeting Thursday evening, November 1, 1923. Dinner was served at 6:30 o'clock following which papers and discussions were given. The program of papers included:

"Conveyor Sprayer for Enamels," by F. G. Jaeger.

"Geology of Some of Our Missouri Clays," by S. M. Richards.

"Denmark and a Little about Danish Clay Products," by Julius Keyser.

There was an excellent attendance and the usual enthusiasm which marks the meetings of the local sections was enjoyed.

NOTES AND NEWS

SHORT COURSE AT THE UNIVERSITY OF ILLINOIS

The University of Illinois announces a Short Course in Clay Working and Enameling to be given January 14 to 26, 1924.

The course is designed to meet the requirements of practical men. It will deal with the principles underlying the work of managers, superintendents, foremen, burners and others who may be concerned with the manufacture of ceramic products.

A common school education will suffice as preparation for the course. No fees are required, but a contribution of one dollar toward the expense of printing leaflets necessary in certain courses is to be made by each person upon registration.

The course of instruction will include lectures, laboratory work and informal discussions. Besides the members of the staff of the Department of Ceramic Engineering and members of the Engineering and other faculties of the University of Illinois, it is expected that R. M. Howe of The Kier Fire Brick Company, Pittsburgh, Pa., formerly of Mellon Institute, R. R. Danielson of the U. S. Bureau of Standards, and Professor A. S. Watts, Head of the Department of Ceramic Engineering of Ohio State University, will assist.

Programs may be had upon application to the Department of Ceramic Engineering, University of Illinois, Urbana, Illinois.

CERAMICS VOCATIONAL COURSE AT NEWELL HIGH SCHOOL

Under the provisions of the Act relating to the coöperative arrangement between the U. S. Government and the States for the provision of industrial training a short course has been established at the Newell, W. Va. High School under the direction of the Department of Industrial Training, at the University of West Virginia.

This course is intended to cover the principles underlying the manufacture of pottery, with as close application to shop conditions as possible. It will be continued for 17 weeks, the classes being held on two evenings each week and each period being one and

one-half hours. The instruction is being given by J. W. Hepplewhite, of the E. M. Knowles China Co., Newell, W. Va., and R. V. Miller, of the Knowles, Taylor and Knowles China Co., East Liverpool, Ohio. Both are graduates of Ohio State University. They are being assisted by A. V. Bleininger, of the Homer Laughlin China Co. Supervision of the course is being exercised by Professor Maclin, of the University of West Virginia, Morgentown, W. Va., and Prof. A. D. Osborne, Supt. of Schools, Grant District, Hancock County.

At the first meeting held, November 5th, some 30 persons enrolled but additional names are being received daily so that an enrollment of at least fifty is expected. No tuition fee is required for residents of West Virginia but a small charge will be made for those residing outside of the state to help defray that part of the cost which is paid by the Newell school district.

NEW ORGANIZATION OF POTTERY SUPERINTENDENTS AND FOREMEN

By A. V. Bleininger

On Friday, November 16th, a large number of men engaged in supervisory positions of the pottery industry gathered in the rooms of the Pottery Manufacturers Club, East Liverpool, Ohio, in response to a call by C. F. Goodwin. The object of the meeting was the discussion of the possible organization of the works superintendents and foremen into an association having for its object the exchange of experiences connected with the operation of the plants. The idea met with immediate approval and was discussed at some length by a number of persons. Herbert Goodwin was elected chairman of the organization and Charles F. Goodwin, secretary. It was decided to hold monthly meetings to be arranged by a program committee which is to be appointed prior to each session. It appeared to be the desire of the members to discuss first of all some of the rules governing the matter of discharge and the hiring of operatives as well as others having to do with the practical side of plant operation. These topics were considered at length but all action was postponed until the next meeting. It would seem that this new organization will fill a long felt want and should prove successful since it has the support of so many men active in the industry.

DEAN COOLEY RESIGNS

Resignation of Mortimer E. Cooley, dean of the College of Engineering and Architecture of the University of Michigan, as president of the American Engineering Council of the Federated American Engineering Societies was announced at the opening session of a two-day meeting of the Executive Board of the Council held in Rochester, N. Y., October 12.

Dean Cooley, in presenting his resignation to the Board, said that he retires on account of ill health. He also made it known that he has been granted leave of absence by the University of Michigan for the second half of the academic year of 1923–1924.

Dean Cooley, it will be recalled, was among the principal speakers on the opening program of the Pittsburgh Convention meeting in February, 1923.

B. A. FORD, SECRETARY NATIONAL LIME ASSOCIATION

Burton A. Ford has been named Secretary and General Manager of the National Lime Association. This action was taken at a regular meeting of the Board of Directors, held in Chicago on October 11, 1923.

For the past three months Mr. Ford has been Acting Secretary of the Association, having been appointed to this position at the Annual Convention held last June. He is a graduate of the University of Maryland, and until the summer of 1922 was with the Virginia-Carolina Chemical Company in the capacity of Division Manager, and was also Secretary-Treasurer of the Bryant Fertilizer Company. In the summer of 1922 he became Assistant to W. R. Phillips, who was then General Manager of the National Lime Association, so he is thereby well qualified to handle his present position.

MINUTES OF MEETING OF CONFERENCE ON SPECIFICATIONS FOR REFRACTORIES[1]

By R. F. Geller[2]

This was the third of a series of conferences for the purpose of preparing specifications for refractories used by the Departments of the Federal Government.

The meeting was called to order at 10:15 A.M.

The following members were present:

R. F. Geller, Vice-Chairman, Bureau of Standards.

W. L. Pendergast, Bureau of Standards.

F. J. Quirk, Treasury Department.

D. B. Downer, Navy Department.

F. M. McGeary, Navy Department.

W. A. E. Doying, Panama Canal.

W. F. Fulweiler, Chairman of Committee C-8 of the American Society for Testing Materials, 319 Arch Street, Philadelphia, Pa.

J. S. McDowell, Refractories Manufacturers Association, Harbison-Walker Refractories Co., Pittsburgh, Pa.

George A. Balz, Refractories Manufacturers Association, Seaboard Refractories Co., Perth Amboy, N. J.

L. C. Hewitt, Refractories Mfg. Association, Laclede-Christy.

M. C. Booze, Refractories Mfg. Assn., Mellon Institute, Pittsburgh, Pa.

R. M. Howe, Refractories Mfg. Assn., Kier Fire Brick Co., Pittsburgh, Pa.

F. A. Harvey, W. A. Hull and E. L. Lasier were unable to be present.

The morning session was devoted to a discussion of the Progess Report[3] of work, carried out in the Bureau of Standards on a representative number of commercial refractories, as suggested at the second conference of the series which was held on March 8, 1922.

The afternoon session was opened with a discussion lead by Mr. Fulweiler, in which a scheme for classifying refractories according to the intended service, was presented. A working basis for such a scheme has been developed by Committee C-8 of the American Society for Testing Materials and is published in a Report of Committee C-8, a reprint of which was furnished to each member. Following this discussion, the accompanying specifications for boiler setting refractories were developed and tentatively approved.

Tentative Specifications for Boiler Setting Refractories

1. Designation.—The material covered by these specifications is a brick of special or standard shape composed of heat resistant clay or clays and which has been burned to produce the desired strength and structure.

[1] The Bureau of Standards, Washington, D. C., Oct. 23, 1923.

[2] Vice-Chairman.

[3] R. F. Geller, "Progress Report," *Jour. Amer. Ceram. Soc.*, **6** [10], 1098 (1923).

2. Workmanship.—(1.) All brick of the nine inch series must be uniform and regular in shape. They shall not vary from specified dimensions more than $^1/_8$" in width and thickness, and $^3/_{16}$" in length. For special shape brick, no dimension shall vary more than 2.0% from the dimension specified, unless greater variation is allowed by contract, but in no case shall a variation of less than $^1/_8$" be specified.

(2.) Brick shall be compact, of homogeneous structure, free from checks, cracks, voids or soft centers. They shall be free from such swells, warps, twists, or distortions as will prevent ready and accurate laying up with a maximum joint of $^1/_8$". All corners shall be sufficiently solid and strong to prevent excessive crumbling or chipping when handled.

3. Classes.—The refractories covered by these specifications shall be divided into six classes, as follows: SH 75; H 75; H 57; M 1; H 25; and M 7.

4. Definitions. Class SH 75.—Refractories of this class are intended for use under the most severe conditions of boiler practice, such as in marine boilers used by the Navy and in plant installations designed to operate at an average rating of not less than 175. Material of this class should have high resistance to slagging, spalling and severe temperatures.

In the U. S. Navy service refractories of Class SH 75 are used in oil fired boilers operated at greater than a 500 per cent rating, and where severe vibrations and rapid changes in temperature occur. In this service the brick are secured by anchor bolts.

Class H 75.—Refractories of this class are intended for use under conditions such as are encountered in general boiler practice. For this class, resistance to slagging, spalling and high temperature is important.

Class H 57.—Refractories of this class are intended for use under conditions where resistance to spalling is not of great importance and where resistant to slagging and high temperature is important. In general boiler practice they may be used in the side walls but, if the refractories used are limited to one brand, material of Class H 75 is recommended.

Class M 1.—Refractories of this class are intended for use at moderate temperatures such as are encountered in hand-fired boilers operated at an average rating not exceeding 125. Resistance to spalling and slagging is important under these conditions of temperature.

Class H 25.—This class is intended primarily for refractories of siliceous nature and for service in which resistance to slagging and spalling is not of particular importance, but in which the refractory is expected to resist deformation under load at relatively high temperatures. In general boiler practice, such conditions are encountered in sprung arches.

Refractories of class H 25 are particularly adapted for service under conditions where reistance to deformation under load, with soaking heats at relatively high temperatures, is important but where there is no marked fluctuation of temperature below approximately 650°C.[1]

Class M 7.—This class is intended primarily for refractories of siliceous nature, for service at moderate temperatures, and under the conditions where resistance to spalling and slagging is not important, but where resistance to deformation under load is important.

Refractories of this class are particularly adapted for service under conditions where resistance to deformation under load, with soaking heats at moderate tempera-

[1] Refractories of Class H 75 which withstand the load test satisfactorily may be included in this class.

tures, is important, but where there is no marked fluctuation of temperature below approximately 650°C.[1]

5. Qualifications. Class SH 75.—*a.* The softening point shall be not less than that of standard pyrometric cone number 32 (approximately 1670°C).

b. The material shall withstand fifteen (15) quenchings without failure.

c. The absorption after reheating should be not less than 6% nor more than 12%, but the failure of the absorption to lie between the limits specified shall not be considered sufficient basis for rejection.

d. Refractories intended for use by the U. S. Navy and the U. S. Shipping Board shall pass the Simulative Service Test.

Class H 75.—*a.* The softening point shall be not less than that of standard pyrometric cone number 31 (approximately 1650°C).

b. The material shall withstand twelve (12) quenchings without failure.

c. The absorption after reheating should be not less than 6% nor more than 12%, but the failure of the absorption to lie between the limits specified shall not be considered sufficient basis for rejection.

Class H 57.—*a.* The softening point shall be not less than that of standard pyrometric cone number 31 (approximately 1650°C).

b. The material shall withstand five (5) quenchings without failure.

c. The absorption after reheating should be not less than 2% nor more than 12%, but the failure of the absorption to lie between the limits specified shall not be considered sufficient basis for rejection.

Class M.—*a.* The softening point shall not be less than that of standard pyrometric cone number 29 (approximately 1610°C).

b. The refractory shall withstand two (2) quenchings without failure.

Class H 25.—*a.* Siliceous refractories shall contain 70% or more, total SiO_2.

b. The softening point shall be not less than that of standard pyrometric cone number 30 (approximately 1630°C).

c. The material shall withstand eight (8) quenchings without failure.

d. The deformation under load shall not exceed three (3) per cent.

Class M 7.—*a.* Siliceous refractories shall contain 70%, or more, total SiO_2.

b. The softening point shall be not less than that of standard pyrometric cone number 28 (approximately 1590°C).

c. The material shall withstand four (4) quenchings without failure.

d. The deformation under load shall not exceed four (4) per cent.

6. Methods of Testing.—*A.* The content of total silica shall be determined by analytical methods described under the A. S. T. M. standard method, Serial Designation C 18–21.[2]

B. The softening point shall be determined according to the A. S. T. M. Standard Method of Test for Softening Point, Serial Designation C 24–20.

C. The quenching test shall be conducted on brick which have been heated uniformly, under no load, at 1400°C for five hours, and allowed to cool slowly to room temperature.

The quenching is conducted in the following manner: the brick is heated by placing in the door of a suitable furnace which is being held at a temperature of

[1] Refractories of Class M 1 which withstand the load test satisfactorily may be included in this class.

[2] As an alternative method the uncombined silica may be determined by petrographic analysis, in which case it shall be not less than 35% for Class H 25 and Class M 7 refractories.

850 °C. The heated end of the brick should be flush with the inner face of the furnace and the outer end should be exposed to the free circulation of air.

At hourly intervals the hot end of the brick is immersed in running water for three (3) minutes and to a depth of four inches. The brick is then removed, allowed to steam in the air for five minutes, and returned to the furnace door. This cycle is repeated until the specimen has failed.

The brick is considered to have failed when the heated end has completely spalled away, or when the structure of the brick has become so weakened that it can be easily removed with the hand.

The results on any one brand shall be reported as the average of five specimens.

D. The absorption shall be determined for brick which have been heated uniformly, under no load, at 1400 °C for five hours, and allowed to cool slowly to room temperature.

The test shall be conducted on specimens not less than one hundred (100) grams in weight, one specimen to be taken from each of five brick of any one brand, and the average result reported.

The per cent absorption shall be determined according to the following formula:

$$\text{Per cent absorption} = \frac{W - D}{D}.100$$

W = weight of specimen after having been boiled in water for two hours and allowed to cool with the water.

D = weight of specimen after having been dried to constant weight at 110 °C.

E. The load test shall be conducted according to the A. S. T. M. Standard Method of Test for Heavy Duty Fire Clay Refractory Material under Load at High Temperatures, Serial Designation C 16–20.

F. The simulative service tests shall be conducted in the following manner:

1. Tests are conducted in small oil-fired furnaces, the dimensions and method of construction of which are shown on attached blueprint. For comparative purposes, one side wall of the combustion chamber is built up of brick and cement of approved brands and the other side wall of brick and cement of the samples under examination. Both walls are backed uniformly with three inches of insulation. An air atomizing fuel oil burner is used. The flame sweeps the length of the furnace, curves upward and returns to the front, then up the stack from which it escapes horizontally towards the rear of the furnace.

2. The test consists of two runs, each of 24 hours duration, at furnace temperatures of 1600 and 1670 °C respectively.

3. During each run the following temperature determinations are made:

Furnace temperatures.

Temperatures of outer face of brickwork of each side wall at front and rear of furnace.

4. Furnace temperatures are determined at quarter-hourly intervals with a Leeds and Northrup Optical Pyrometer sighting on flame through front of furnace above burner.

5. Temperatures of the outer face of the brickwork of each side wall are determined at half-hourly intervals, with a Leeds and Northrup Optical Pyrometer sighting on the brickwork through sillimanite tubes, the ends of which are placed flush with the wall. The tubes are carefully lagged and plugged to prevent radiation losses.

6. A spalling test is conducted at the conclusion of each run by injecting cold air at high velocity into the furnace immediately after shutting off the oil supply to the burner. The injection continues until the walls are cool.

7. The comparative heat-insulating properties together with the relative conditions of the side walls determine whether or not the material under test is acceptable for use in the Naval service.

7. Acceptance.—For refractories other than those intended for use by the U. S. Navy and the U. S. Shipping Board, the combined results of workmanship, chemical or petrographic analysis, fusion point, quenching, and load test where required, shall be considered as a suitability test.

For refractories intended for use by the U. S. Navy and the U. S. Shipping Board, the suitability test shall include the simulative service tests, but at the discretion of the purchasing officer the simulative service test may replace all other tests included in the suitability test.

Workmanship and softening point determination shall be considered as a control test.

8. Retesting.—Notice of the rejection of a shipment based on these specifications must be in the hands of the consignor, unless otherwise specified, within ten days after the receipt of the shipment at the point of destination. If the consignor desires a retest, he shall notify the consignee within five (5) days of receipt of said notice.

Following the formulation of the above specifications, which were based on the results of the laboratory work carried out by the Bureau of Standards and the observations and tests conducted by the various members of the conference, the service tests submitted by Stone and Webster were taken under consideration. These were found to cover so many phases of the problem, and the data was of such detailed nature, as to require considerable study and correlation. It was, therefore, decided to give these further consideration and to report the results of this study at a later date.

The conference adjourned at 5:15 P.M.

REPORT OF CONFERENCE ON HEAT TRANSFER THROUGH WALL STRUCTURES[1]

The conference convened at 11:00 A.M. Oct. 22, 1923, Dr. H. C. Dickinson presiding.

The following persons were present:

Virgil A. Marani, The Gypsum Industries, 844 Rush Street, Chicago, Ill.

C. H. Parkin, The Vortez Manufacturing Co., Cleveland, Ohio.

Wm. Carver, The Common Brick Mfrs. Association, 2121 Discount Building, Cleveland, Ohio.

R. P. Brown, The National Lime Association, 918 G Street, Washington, D. C.

Henry E. Stringer, Hydraulic Press Brick Company, Colorado Building, Washington, D. C.

F. J. Huse, Hollow Building Tile Mfrs. Association, 111 West Washington Street, Chicago, Ill.

Dudley F. Holtman, National Lumber Mfrs. Assoc., International Bldg., Washington, D. C.

Warren E. Emley, Bureau of Standards, Washington, D. C.

E. F. Mueller, Bureau of Standards, Washington, D. C.

M. S. Van Dusen, Bureau of Standards, Washington, D. C.

H. C. Dickinson, Bureau of Standards, Washington, D. C.

The conference consisted chiefly in a general discussion of the subject of heat transfer as applied to building walls, the following being a brief report of the principal points brought out in the discussion.

[1] Held at the Bureau of Standards, Washington, D. C.

About two years ago a similar conference was held at the Bureau, several of the men listed above being present. It was the unanimous opinion at that time that an investigation of the heat transfer through, and the moisture condensation on, building walls was very desirable and should be undertaken preferably by the Bureau of Standards. Ways and means were discussed, particularly with reference to financial support, and it was the opinion that the matter should be brought to the attention of Congress, but no formal action was taken.

About a year after this, a small allotment was made to the heat division of the Bureau to begin work on the heat transfer through walls. At the present time this investigation is producing definite results on the heat transfer through wall panels 6 ft. high by 3 ft. wide, under dry conditions and with negligible wind pressure on the two sides. The temperatures on each side of the panels can be varied anywhere within the range 0°F to 120°F. The method gives the relative contribution of each of the components of the wall, as well as the outside and inside surfaces, to the total resistance to heat flow. About ten panels have been built, representing some typical walls used in the construction of small buildings. They include the following:

Brick—9″—plastered inside directly on the brick.

Brick—9″—furred and plastered on inside.

Hollow tile—9″—plaster inside, stucco outside, air spaces horizontal. Two types of tile.

Hollow tile—9″—same with air spaces vertical.

Frame wall—2 x 4 studding: sheathing, building paper, metal lath and stucco on outside: wood lath and plaster on inside.

Concrete—8″—hollow blocks. Two kinds of concrete mix, one cinder.

Brick—9″—Ideal construction containing air spaces.

The panels are not special but represent as far as possible ordinary building construction.

The present conference was called to stimulate interest in this work, with the idea of giving it financial or other support in some way, so that it will be possible to make the investigation more complete in a shorter time, and also to investigate the possible effects of the infiltration of air and the condensation of moisture.

It was suggested that this work be done in coöperation with that of the Research Bureau of the American Society of Heating and Ventilating Engineers at Pittsburgh. The exact status of their work on heat transfer was unknown to the conference. The point was brought out that although a certain amount of coöperation was desirable, yet the confidence in the results would be much greater if similar results were obtained by more or less independent means.

The question of the relative heat losses through windows, doors, walls, and ceilings was brought up and it was agreed that this was a question for which an answer was required.

The question of laboratory tests versus tests under actual service conditions was discussed at length. It was argued that tests on actual buildings exposed to the weather were required in order to get results which could be applied to practical conditions. On the other hand it was pointed out that the comparison of various constructions under such variable conditions was in all probability subject to greater uncertainty than the application of laboratory data to service conditions. In laboratory tests the conditions can be varied at will and the effect of different components of the wall determined separately, with the result that much less time is consumed in covering the entire field. Tests can be made under various wind conditions without the variability imposed by the weather outside, and the effect of the wind observed with greater certainty than could be obtained under variable conditions. It was, however, considered desirable to check the laboratory tests on a few typical walls under actual service conditions. The sug-

gestion was made that a long structure could be built containing a number of rooms, each having a different exposed wall construction. By maintaining all the rooms at the same temperature by measured heat supply, the heat transmission of the various exposed walls could be compared under the same outside weather conditions.

It was moved and carried that the participants in the conference report to the respective associations they represent the necessity for carrying on the work on heat transfer through various types of exterior walls, recommend such financial support as is necessary, take up the matter with Secretary Hoover for the purpose of obtaining his consent and support, request manufacturers to write stating what types of walls they want tested, and ask the Bureau of Standards to formulate a program.

In the discussion of this motion it was estimated that $10,000 per year would cover the cost. In case any part of this was furnished by the industries, the question of a fair apportionment would have to be decided later on the basis of the importance of the subject to the individual industry. It was also pointed out that the estimates of the Bureau for the next fiscal year (beginning July 1, 1924) include allotments for this work and that any influence brought to bear on the budget committee by the industries would go a long way toward retaining the increases asked for. As another possibility in assisting the work it was suggested that the industries might detail men to the Bureau for certain lengths of time, as research associates. In this way the men get the benefit of training at the Bureau and both the industries and the Bureau profit by the arrangement.

The motion was made and carried that the industries be requested to furnish free of charge such materials as are necessary for the conduct of the tests to be laid out by the Bureau of Standards.

The motion was made and carried that the report of the meeting be sent to all parties listed below, and that they be requested to endorse the program.

American Society of Heating and Ventilating Engineers,
American Society of Refrigerating Engineers,
American Society of Civil Engineers,
American Society of Mechanical Engineers,
American Institute of Architects,
American Concrete Institute,
American Ceramic Society,
American Face Brick Association,
Associated Metal Lath Manufacturers,
Bureau of Standards,
Common Brick Manufacturers Association of America,
Concrete Products Association,
Engineering Council,
Forest Products Laboratories,
Gypsum Industry,
Hollowing Building Tile Mfrs. Association,
National Lime Association,
National Lumber Mfrs. Association,
National Association of Building Owners & Mfrs.,
National Housing Association,
Portland Cement Association.

The motion was made and carried that the American Society of Heating and Ventilating Engineers and the American Institute of Architects be invited to join the committee.

The motion was made and carried that Mr. Marani be appointed to interview Mr. Hoover in regard to the proposed program.

The motion was made and carried that the committee be considered as an advisory committee to the Bureau of Standards, governing the work outlined, and that Mr. Holtman be appointed chairman.

NOTES FROM THE U. S. BUREAU OF MINES

Investigation of Mineral Fillers

The investigation of the availability of certain minerals for use as fillers, together with a study of their physical and chemical characteristics, and their adaptability to commercial uses, is being continued by the Department of the Interior, through the Bureau of Mines. The South has extensive deposits of clays, ochres, bauxite, talc, graphite, etc., and the purpose of this study is to determine their value for use as fillers in making linoleum, paper and other commercial products.

The laboratory study of the size and character of grains of non-metallic mineral fillers has been completed. The results show that these characteristics have an important bearing on the applicability of a mineral filler and the types of manufactured products in which it can be used.

Laboratory work on Georgia and Alabama white clays to determine their value for filler use has been completed. The samples investigated included 31 Georgia and 11 Alabama clays. Of the Georgia clays, 17 were selected for more extended semi-commercial tests, and 500-pound samples were sent to the Ceramic Experiment Station of the Bureau of Mines at Columbus, Ohio, for washing, pulverizing and dispatching to the manufacturers who are coöperating in the factory tests. The laboratory tests have shown that a number of the Georgia clays tested are equal or superior in quality to the imported foreign clays now largely used in the paper trade. The bureau's tests also indicate the clays are of value in rubber filling, and rubber manufacturers are being furnished with samples of the Georgia clays, to test their value in rubber compounding.

Electrical Conductivity of Refractory Materials at High Temperatures

Reliable and comparable data are needed on the electrical resistivity at high temperatures of the refractory materials suitable for furnace linings. In the performance of experimental work by the Department of the Interior, at the Bureau of Mines Ceramic Experiment Station, Columbus, Ohio, methods and apparatus for making such measurements have been developed. Test pieces for determination of the electrical resistance were prepared from fire clay, kaolin, alundum, diaspore, thoria, silica, zirconia, magnesite, silicon carbide, sillimanite, zirkite, and magnesium spinel. Resistance measurements have been run on half of the pieces. Carbon electrodes are employed, measurements being run in an atmosphere of pure nitrogen to a temperature of 1400°C in a gas-tight platinum-resistance furnace.

Dolomite for Refractories

Research work on the utilization of dolomite in refractories is being continued by the Department of the Interior at the Ceramic Experiment station of the Bureau of Mines, Columbus, Ohio. The main problem being studied is to combine the lime in the dolomite so that it will be nonslaking and at the same time hold up the refractories, thereby rendering available abundant deposits of dolomite for extensive use as a basic refractory. Work previously done by the Bureau of Mines on different fluxes for

rendering dolomite refractories nonslaking indicated that by careful selection and preparation, refractory bricks could be made, one of the best fluxes tried being alumina-iron flux. More recent work done by the bureau consisted of slaking time tests on varying proportions of dolomite mixed with an alumina-iron flux. The proportion of flux to dolomite was varied between 5 and 20 per cent. The refractory properties as well as the slaking tendency of these mixes were studied. After the best proportion of flux to ground rock was determined, bricks were made by the soft mud and dry press processes, using both organic and inorganic binders. Then methods of firing to produce sound bricks were studied. As a result, a composition has been found which, when compounded with the proper binder and burned after a given procedure, produces a strong, nonslaking brick of high refractoriness. The bricks are satisfactory in every respect, except that uniform shrinkage has not been completely attained. During the coming year, bricks will be produced and tried out in the industry.

Preparation of Super-Refractories

Experimental work in the development of refractories from artificial sillimanite designed to be superior to the natural refractories now in use is in process at the Northwest Experiment Station of the Bureau of Mines, Department of the Interior, at Seattle, Wash. The work is being done in coöperation with ceramic trade interests. Sillimanite is the normal silicate of alumina, containing 63 per cent Al_2O_3 and 37 per cent SiO_2, and is also made artificially in the electric furnace. The best compound found is one a little richer in alumina than the pure sillimanite. One of the principal problems is the presence of impurities in the local clays that affect the fusing point. It was found that iron oxide present as impurity could be partly removed by reduction, but magnesia and lime could not be removed.

Effect of Carbon Monoxide on Refractories

Large-scale experiments with an electrothermic dry distillation process for the treatment of zinc ores, recently undertaken by the Mississippi Valley Experiment Station of the Bureau of Mines, Department of the Interior, were hampered by the rapid disintegration of condenser linings made of ordinary fire brick. A study of the problem developed that the action of carbon monoxide was largely responsible for the disintegration, due to the increase in volume caused by carbon deposition around particles of iron oxide contained in the refractory material. Thus the trouble can be avoided by the use of iron-free refractory material. Silica brick or high-grade fire brick free from iron were found to be satisfactory. Results of these experiments have widespread application as refractory brick must withstand the action of carbon monoxide gas when used in coke ovens, in iron-blast furnaces, in producer gas flues, and in the checker work of regenerative furnaces fired with producer gas.

Refractories for Steel Making

A survey of operating conditions obtaining in open hearth steel practice will be made by the Department of the Interior, at the ceramic experiment station of the Bureau of Mines, Columbus, Ohio, for the purpose of determining wherein available commercial refractories fall short of giving ideal service. The Bureau of Mines plans later, in coöperation with the steel industry, to undertake the development of ideal refractories for specific services.

SIZES AND WEIGHTS OF HOLLOW BUILDING TILE SIMPLIFIED

As a result of a general conference of manufacturers, distributors, and users of hollow building tile held at the Department of Commerce on October 19, 1923, under the auspices of the Division of Simplified Practice, it was unanimously agreed and adopted that definite weights and sizes of that commodity be considered as the standard of practice for the industry for one year effective January 1, 1924.

A survey of variety in sizes, dimensions, and weights reported at the preliminary conference of manufacturers held at the Department on June 19, 1923, showed 36 different sizes, each made in a wide variety of weights. A compilation and review of the figures brought out by this survey was made by the Standards Committee of the Hollow Building Tile Association and was used as a basis for adoption at the general conference.

Mr. Hudson of the Division of Simplified Practice opened the conference as presiding Chairman and gave a brief outline of the accomplishments of other industries in

STANDARD LOAD BEARING WALL TILE

End Construction		Weight
3 3/4 x 12 x 12	3 cells	20 lbs.
6 x 12 x 12	6 cells	30 lbs.
8 x 12 x 12	6 cells	36 lbs.
10 x 12 x 12	6 cells	42 lbs.
12 x 12 x 12	6 cells	48 lbs.
Side Construction		
3 3/4 x 5 x 12	1 cell	9 lbs.
8 x 5 x 12	2 cells	16 lbs.
8 x 5 x 12 ("L" shaped)		16 lbs.
8 x 6 1/4 x 12 ("T" shaped)	4 cells	16 lbs.
8 x 7 3/4 x 12 (square)	6 cells	24 lbs.
8 x 10 1/4 x 12 ("H" shaped)	7 cells	32 lbs.

STANDARD PARTITION TILE

3 x 12 x 12	3 cells	15 lbs.
4 x 12 x 12	3 cells	16 lbs.
6 x 12 x 12	3 cells	22 lbs.
8 x 12 x 12	4 cells	30 lbs.
10 x 12 x 12	4 cells	36 lbs.
12 x 12 x 12	4 cells	40 lbs.

STANDARD SPLIT FURRING TILE

2 x 12 x 12	9 lbs.

STANDARD BOOK TILE

3 x 12 x 18 to 24	18 lbs. per sq. ft.

the building material field who have effected economies through the application of Simplified Practice to their commodities.

The conference decided to vote on the list submitted by sections and the discussion opened on the 12 x 12 x 12 standard load-bearing wall tile for end construction. It was contended that this size did not permit of combined brick and tile construction for the city of Washington. It was brought out by the tile manufacturers that this size

would adequately meet the requirements of any construction and that its failure to do so in Washington was due to the fact that builders in that vicinity were not using the standard size brick as adopted at the Brick Conference held at the Department of Commerce on June 21, 1923.

Mr. Sturtevant of the Association explained to the conference that the last four units of tile as listed under standard partition tile were under a course of tests at the Bureau of Standards and their findings would determine whether they would be classed as floor tile of standard weights. The remaining groups were voted on and unanimously adopted.

After considerable debate as to tolerance for weights and dimensions, it was unanimously passed that not more than 5 per cent tolerance over or under would be allowable for weights and 3 per cent over or under for dimensions covering length, width, and height.

January 1, 1924, was set as the date the recommendation should become effective and to remain in force for a period of one year from that date.

A standing committee of the conference consisting of three representatives of manufacturers, three of distributors, and three of consumers was decided upon as a means of providing a follow-up to insure the adoption of the simplifications embodied in the recommendation of the conference; to effect a greater degree of contact and coöperation between the Department and the industry; and to consider further eliminations or substitutions in the existing varieties of tile. The personnel of this committee will be announced later.

The accompanying list gives in detail the weights, sizes, and types of tile adopted at the conference.

Personnel in Attendance

Bevier, P. H., Hollow Building Tile Association, Flatiron Bldg., New York City.
Brady, Wm. G., 439 Treasury Building, Washington, D. C.
Cartwright, Frank C., Division of Building & Housing, Department of Commerce.
Dailey, E. W., North Iowa Brick & Tile Co., Mason City, Iowa.
Deckman, Chas. G., Medal Paving Brick Co., Cleveland, Ohio.
Dixon, C. W., Columbus Brick & Tile Co., Columbus, Ga.
Downer, H. C., The Malvern Fire Clay Co., Malvern, Ohio.
Ginder, J. W., Federal Specification Board, Treasury Department, Washington, D. C.
Graham, Bert J., Denison Interlocking Tile Corpn., Guardian Bldg., Cleveland, O.
Green, A. L., American Railway Association, Chicago, Ill.
Healy, John P., Building Officials Conference, 108 Municipal Bldg., Washington, D. C.
Holden, P. E., Asst. Mgr., Fabricated Production Department, United States Chamber of Commerce, Washington, D. C.
Hutton, Jr., Wm. Troy Fireproofing Co., Troy, N. Y.
Ingberg, S. H., American Society for Testing Materials, and National Bureau of Standards.
Juse, Frank J., Chief Engineer, Hollow Building Tile Assn., Chicago, Ill.
Keasbey, H. M., National Fire Proofing Co., Fulton Bldg, Pittsburgh, Pa.
Peace, T. M., Alfred, New York.
Rommel, Edward, Consolidated Clay Products Co., Canton, Ohio.
Sleeper, J. S., Secretary, Hollow Building Tile Assn., Chicago, Ill.
Snow, W. A., American Clay Products Co., 175 Fifth Ave., N. Y. City.
Straight, H. R. Hollow Building Tile Assn., Adel, Iowa.
Sturtevant, E. R., Hollow Building Tile Assn., Dallas, Texas.
Thomas, H. B., National Fire Proofing Co., 949 Broadway, New York City.

Wallace, R. G., Hollow Bldg. Tile Assn., Fulton Bldg., Pittsburgh, Pa.
Whitacre, J. B., Whitacre-Greer Fireproofing Co., Waynesburg, Ohio.
Wilson, Wm. E., Mason City Brick & Tile Co., Mason City, Iowa.
Wright, Francis, H., Hay-Walker Brick Co., 52 Vanderbilt Ave., Pittsburgh, Pa.
Yepsen, V. L., Anness and Potter Fire Clay Co., Woodridge, N. J.

DIVISION OF SIMPLIFIED PRACTICE, DEPARTMENT OF COMMERCE
HUDSON, R. M.
COLWELL, H. R.

CALENDAR OF CONVENTIONS[1]

Organization	Date	Place
AMERICAN CERAMIC SOCIETY (Annual Meeting)	Feb. 4–8, 1923	Atlantic City
American Concrete Institute	Feb. 25–28, 1924	Chicago
American Face Brick Assn.	Dec. 4–6, 1923	French Lick Springs, Ind.
American Institute of Electrical Engineers	Feb. 4–7, 1924	Philadelphia
American Malleable Castings Assn.	Jan., 1924	Cleveland, Ohio(?)
American Road Builder's Assn.	Jan. 14–18, 1924	Chicago
American Zinc Institute	May, 1924	St. Louis, Mo.
Assn. of Scientific Apparatus Makers of U. S. A.	April 18, 1924	Washington, D. C.
Common Brick Mfrs. Assn. of America	Feb. 11, 1924	Los Angeles, Calif.
Gas Products Assn.	Jan., 1924	Chicago
Hollow Bldg. Tile Assn.	Jan., 1924	Chicago(?)
Institute of Metals, Div. of American Institute of Mining and Metallurgical Engineers	Feb., 1924	New York City
Natl. Assn. Brass Mfrs.	Dec., 1923	New York City
Natl. Assn. of Stove Mfrs.	May 7–8, 1924	New York, Hotel Astor
Natl. Bottle Mfrs. Assn.	April 27, 1924	Atlantic City
Natl. Brick Mfrs. Assn.	Jan. 28–Feb. 2, 1924	Cincinnati, Ohio
Natl. Builders Supply Assn., Inc.	Feb., 1924	Chicago(?)
Natl. Electric Light Assn.	May or June, 1924	
Natl. Glass Distributors Assn.	Dec. 4–5, 1923	Pittsburgh, Pa.
Natl. Paving Brick Mfrs. Assn.	Dec., 1923	
Natl. Exposition of Power and Mechanical Engineering	Dec. 3–8, 1923	New York City
Penna. Gas Assn.	April, 1924	Atlantic City
Society of Promotion Engineering Education	July, 1924	Boulder, Colo.
Stoker Mfrs. Assn.	April or May, 1924	(?)
U. S. Potters Assn.	Dec., 1923	Washington, D. C.
Western Society of Engineers	June 4, 1924	Chicago

[1] Further information may be secured through the Chamber of Commerce of U. S., Washington, and World's Convention Dates, New York, N. Y.

American Ceramic Society

Seven Conventions in One

Hotel Traymore

Atlantic City

February 4-9 inclusive

Ceramic Art	Heavy Clay
Enamel	Products
Glass	Terra Cotta
Refractories	White Wares

An Exhibition of Products, Materials and Equipment

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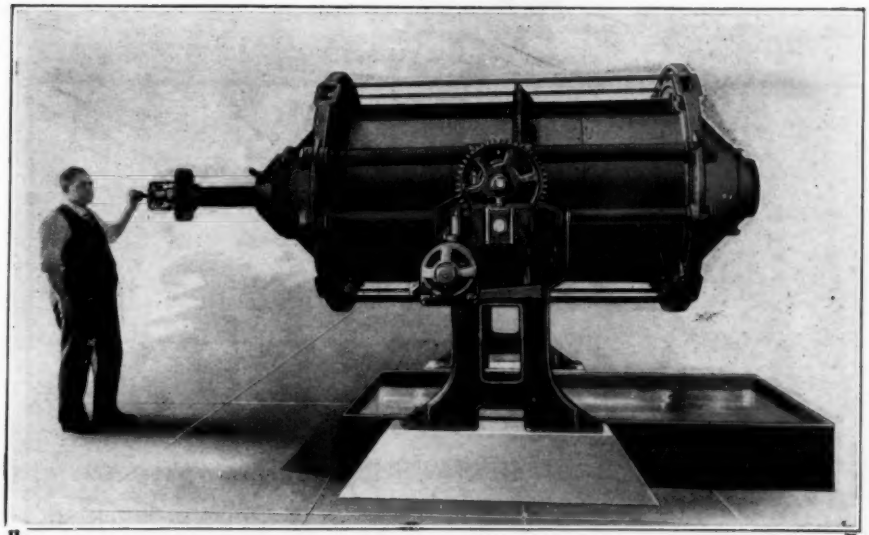

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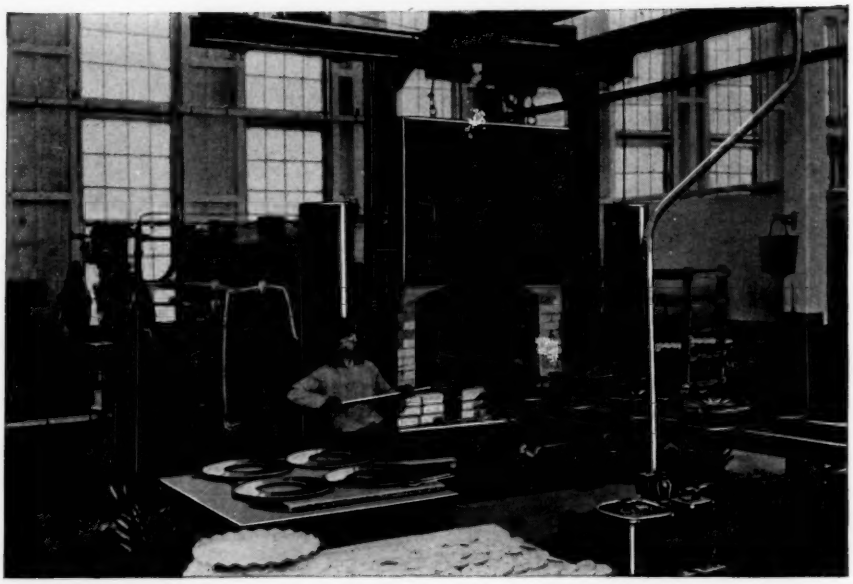

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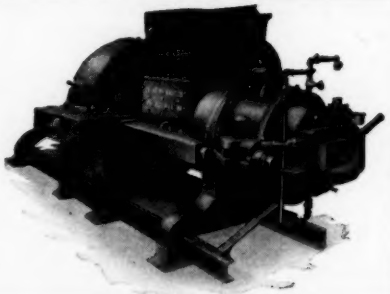

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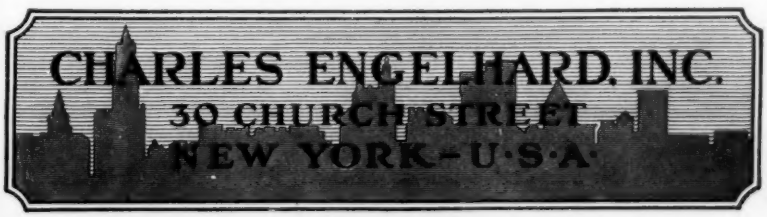

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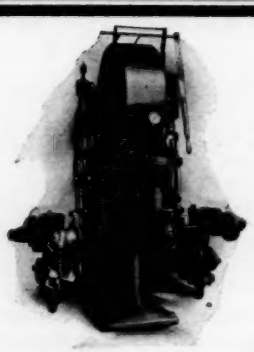

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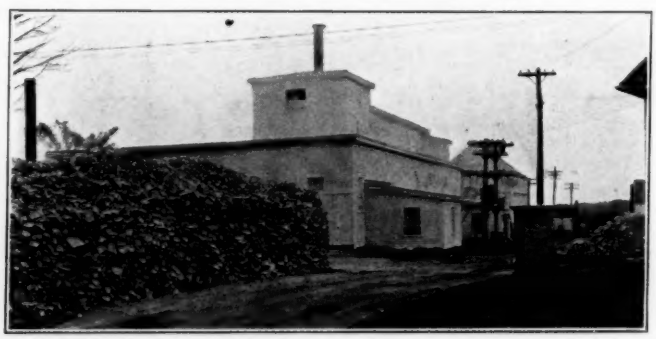

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"IF I HAD IT TO DO AGAIN"

Talk to any man who has an enameling plant and is smelting his own enamels, and he will tell you "If I had it to do again I would never make my own enamels, I would purchase the glass already smelted." "Why the interest on investment, loss of materials and work, the amount is enormous." "I would be thousands of dollars ahead if I had purchased my enamels in the first place."

The man who figures the actual cost of making his enamels is the one who is going to be a PEMCO customer. You can purchase PEMCO glass at less than it costs you to smelt your own.

Ease of application, Uniformity of color, Durability and beautiful finish make PEMCO Enamels most economical and desirable.

You will be surprised at their exceedingly low cost.

Write us for latest prices.

THE PORCELAIN ENAMEL & MFG. CO.,

BALTIMORE, MARYLAND.

This Mark

is your assurance

of—

HIGH GRADE KILN COAL

DISCRIMINATING POTTERS DEMAND—
Seaboard (non-clinkering) Kiln Coal

—because it is uniformly High Grade,—and because they have found it to be entirely satisfactory in the past.

Aside from its High Fusing Point, it contains—

LOW SULPHUR — LOW ASH — LOW VOLATILE

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